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# ***JPRS Report***

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# **Science & Technology**

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***CHINA: Energy***

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# Science & Technology

## China: Energy

JPRS-CEN-91-005

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**Ambitious Construction Program Would Add 45 Million KW in Eighth 5-Year Plan**

916B0023A Beijing JINGJI RIBAO in Chinese  
31 Oct 90 p 1

[Article by reporter Xie Ranhao [6200 3544 3185]: "Construction of Several Large and Medium-Sized Power Plants Unfolds from South to North China, 45,000MW of Generators To Begin Operation During Eighth 5-Year Plan"]

[Text] Based on the need to attain an installed electric power generating capacity in China of 240,000MW by the year 2000 and achieve a net increase of more than 100,000MW in installed generating capacity in 10 years, new construction and expansion of several large and medium-sized power plants from south to north China is now pressing forward. Over 45,000MW in generators are expected into operation during the Eighth 5-Year Plan.

These power plants under construction include six well-known backbone power plants with a total installed generating capacity of 6,400MW and 16 electric power projects with a total installed generating capacity of 5,900MW for which near-term construction starts have been approved by the State Council.

News arriving from all areas indicates that construction of the six large backbone power plants is now proceeding smoothly. After being tested by rainy season flooding, pouring of the large dam at Guangxi's Shitan hydropower station is now proceeding according to plan. Nine main and permanent projects have been inspected and accepted as being of excellent quality. Since starting construction at Hubei's Geheyuan hydropower station with an installed generating capacity of 1,200MW, it has set national records for large hydropower stations in starting construction, flow diversion, and pouring the large dam within the same year, and the main projects are progressing ahead of plans. Construction engineering in preparation for the second phase project at Harbin No 3 power plant is now fully underway. After completion of "five openings and one leveling" projects in the plant area, prefabrication of the foundation pilings for the main plant building was completed. "Five openings and one leveling" work for the first phase project at Jiangsu's Changshu power plant which will have an installed generating capacity of 1,200MW is basically finished. Construction of the 210 meter tall main smokestack for the civil engineering project at Ningxia's Daba power plant was completed ahead of schedule and the boilers have been ignited. It will be connected to the grid and begin generating power at the end of 1991. Shanxi's Shentou No 2 power plant is now rising up at the source of the Sangqian He.

At the same time, after formal approval of the construction start documents for 16 electric power projects by the State Planning Commission, the curtain has opened on construction of these new electric power projects approved by the State Council. They are Shandong Heze

power plant, Henan Zhengzhou heat and power cogeneration plant, Hebei Qinhuangdao power plant first phase project, Jilin Shuangliao power plant, Anhui Huabei power plant fourth phase project, Guizhou Zunyi power plant, Liaoning Tieling power plant, Guangdong Zhujiang power plant, Hubei Yangluo power plant, Beijing No 3 heat and power cogeneration plant, Tianjin Chentang heat and power cogeneration plant, Shanxi Datong No 1 heat and power cogeneration plant, Zhejiang Changxing power plant, Anhui Wuhu power plant, Henan Pingdingshan heat and power cogeneration plant, and Guangdong Shajiao A power plant second phase project.

**Strategic Selection of Nation's Energy/Economic Zones**

916B0020B Beijing GUANGMING RIBAO in Chinese  
17 Nov 90 p 3

[Article by Yang Guangyu [2799 0342 5940]: "Strategic Selection of China's Energy Resource and Economic Zones"]

[Text] China's energy resource base areas are now undergoing a transition from unidirectional excavation to a high-strength comprehensive development phase. The associated transfer of energy resource industry center regions should carry out recombination of the regional economic division of labor within China's energy resource and economic zones and design a system model for our energy resource and economic zones based on the goals and models for comprehensive system reforms in China and on the unique qualities of the energy resource industry to promote rational and effective development of energy resource and economic zones.

According to modern economic growth theory, industrial structure theory, and the principles of regional economics, the guiding ideology for economic development in China's energy resource and economic zones should consider these two areas:

**I. Overall Goals and Strategic Steps for Economic Development**

Economic development in China's energy resource and economic zones from now into the mid-21st Century can be divided into three steps.

The first step spans the 1990's. The focus of our development strategy should be to use developmental construction of the energy resource industry as the guiding force for promoting development of other industries. Based on the structure of demand for energy resources in China, the core of energy resource industry development should shift from the coal industry to combined development of coal and power and to the electric power industry. The basic direction for the energy resource industry to promote other industries is a conversion of the form of energy resources, meaning a shift from the purely energy resource form to the form of industrial products with high energy contents; and using financial,

monetary, enterprise integration, and other forms to achieve a transfer of capital from the energy resource industry to other industry sectors. At the same time, large-scale basic facilities construction that inevitably arises in adaptation to development of the energy resource industry naturally plays a major role in developing pillar industries in energy resource and economic zones and improving the environment in which they exist. Achievement of the strategic goals for energy resource and economic zones during the 1990's will play a prominent role in resolving structural contradictions in national economic development and supporting economic growth, and it will substantially transform living standards in the energy resource and economic zones themselves.

In the second step, which spans the first 20 years of the 21st Century, the guiding goal for economic development in energy resource and economic zones should be to rely on substantial development of the energy resource industry in the Inner Mongolia Autonomous Region and in Shaanxi and Ningxia Provinces to transform the energy resource and economic zones into industrial base areas with high energy contents. Achievement of this strategic goal inevitably will be accompanied by a major strategic shift of the core of energy resource and economic zone energy resource industry regions, by comprehensive extension and intensification of the processing industry in Shanxi, Henan, and Shaanxi, and by the merging or permeation of high-tech industry in the developed regions of China with pillar industries in the energy resource and economic zones. During this strategic phase, the function of China's energy resource and economic zones as national energy resource base areas will begin to weaken and will be replaced by a comprehensive economic development model based on the energy resource industry.

During the third step, spanning the period from the 2020's to the 2050's, China's energy resource structure will be propelled by the scientific and technological revolution and development of the primary energy resource industry will shift to Xinjiang and other areas of west China. On this background, although the energy resource industry in energy resource and economic zones will continue to be an important pillar industry, its strategic status will give way to the metallurgical, machinery, chemical industry and other industrial sectors which have modern technical qualities and they will take over the functions of pillar industries in China's developed regions.

## II. Structural Models of the Economy and Their Evolution

The key to the direction of the development path taken in China's energy resource and economic zones lies in the formation of a rational energy resource economic structure.

1. The first phase of the course of the development strategy for energy resource and economic zones (the

1990's) should make achieving coordinated industrial development the macro management goal of the economic structure. Coordinated development includes external coordination and internal coordination. External coordination mainly involves adaptation to national energy demand and structural requirements to change the situation in which the energy resource industry pulls the national economic growth rate. For this reason, energy resource and economic zones should combine high strength development of coal with super-high strength development of the electric power industry to effectively transform the situation of structural shortages in national energy resource demand. Internal coordination mainly concerns eliminating "bottleneck" states in the load carrying capacity of basic facilities to make matching industries keep pace with the development rate of pillar industries, control "tension" on the energy resource industry by high energy consuming industries, and stabilize the strategic status of the heavy manufacturing industry, raw materials industry, consumer goods industry, and agriculture. In addition, it comprehensively improves industry quality, readjusts the product mix within each industry, and carries out large-scale basic facilities construction in a leading manner.

2. During the second phase of economic development in energy resource and economic zones (first 20 years of the 21st Century), the guiding strategic task should be a comprehensive structural conversion. The structural innovation in development of China's economically developed regions naturally does not mean the retirement of high energy content industries which have relative economic advantages. On this background, whether we are speaking of the direction of national macro investment deployments or of the unique economic advantages of the energy resource and economic zones themselves, all cases require that Shanxi, Shaanxi, Henan, Inner Mongolia, and Ningxia be built into high energy content industrial base areas. For this reason, the metallurgical industry, machinery industry, and chemical industry will become the main forces in economic growth and together with the energy resource industry, consumer goods industry, communications and transport industry, and agriculture will form a new diversified configuration of pillar industries. During this strategic phase, a major change will occur in the strategic functions of energy resource and economic zones: base areas for the outward shipment of coal and electric power will become the main army in China's domestic materials markets.

3. In the third strategic phase (2021 to 2050), the focus of strategic pursuits should be comprehensive elevation of industrial technology. Elevation of industrial technology has three aspects: high-tech industry occupies a definite proportion of the industrial structure; high-tech industry systems are used to reform conventional industrial technical equipment; industrial departments with traditional technical qualities are abandoned. It is very possible that the strategic course of elevation of industrial technology

will be diffuse. For this reason, the long-term strategic pursuits of energy resource and economic zones should make integration of high-tech development its primary goal. In addition, ecological environmental protection and improvement and their development will become important pillar industries.

As integral parts of China's macroeconomic system, energy resource and economic zones should make functional coordination their basis and pursue the goal of coordination of levels and regional coordination. In economic circulation between these two levels, energy resource and economic zones should integrate their own goals with macro goals.

### **A Realistic Approach To Constructing the Shanxi Energy and Industrial Base**

*916B0020A Beijing RENMIN RIBAO in Chinese  
11 Nov 90 p 5*

[Article by Shanxi Provincial governor Wang Senhao [3769 2773 3185]: "Start with Reality in Doing Good Work To Build the Shanxi Energy Resource, Heavy Industry, and Chemical Industry Base Area"]

[Text] Since the 3d Plenum of the 11th CPC Central Committee, outstanding achievements have been made in building the Shanxi energy resource, heavy industry, and chemical industry base area. The process of base area construction and development involved resolutely starting from reality and continually solving problems. The achievements made in base area construction were a victory for the party's ideological line of seeking truth from facts.

#### **I. Construction of the Shanxi Energy Resource, Heavy Industry, and Chemical Industry Base Area Is a Strategic Policy Decision That Conforms to China's National Conditions and Shanxi's Conditions**

Raw coal output in Shanxi reached 275 million tons in 1989, a more than two-fold increase over 1978. Our coal output now accounts for one-fourth of China's total coal output and we shipped out 199 million tons of coal during 1989, nearly 80 percent of net out-shipments of coal from all of China's coal producing provinces and municipalities. The development of coal and electric power has also promoted development of other industries and invigoration of Shanxi's economy. Practice has proven that the decision to build the Shanxi energy resource, heavy industry, and chemical industry base area was a correct one. Of course, the price of coal being too low for several years, the environmental pollution caused by developing coal, destruction of water resources, and other problems have led to some divergence of views regarding construction of the energy resource, heavy industry, and chemical industry base area. These questions must be analyzed by seeking truth from facts. First, we must look at the essence of the problems. Coal is Shanxi's biggest resource advantage. Seizing this coal advantage and developing coal production is an important way to invigorate Shanxi's

economy. The problems that arise from developing coal production should be examined and resolved, but we cannot hold back for fear of a slight risk and attend to trifles to the neglect of essentials. Understanding and dealing with problems must begin with the overall situation. On the one hand, China's national economy must grow before it will have the strength to support local development. On the other hand, China's development must rely on fostering local initiative and local development. Of course, there can be conflicts between local interests and overall interests. When this situation appears, local interests must serve national interests. This is the attitude of seeking truth from facts. Thus, we have been unwavering in resolute construction of the energy resource base area. At the same time, we have been concerned with and resolved problems that arise from developing coal resources, attempted to deal properly with the relationship between supporting the nation and invigorating Shanxi and bringing prosperity to its people, and achieving healthy development of the energy resource base area.

#### **II. Begin with Reality, Take the Route of Chinese-Style Development of the Coal Industry**

After deciding to build the Shanxi energy resource, heavy industry, and chemical industry base area, the first problem we encountered was how to do the construction and what route to take. Several decades ago, because we were restricted by the ideology of a single system of ownership, development of China's coal industry mainly relied on building large and medium-sized state-run coal mines. However, relying solely on development of large and medium-sized coal mines could not meet the demand for coal in state construction. The reality we faced was that on the one hand, state construction urgently needed coal but we lacked capital and the construction schedule for large and medium-sized coal mines was long, at least 3 to 5 years and 7 or 8 years in many cases, which was far from meeting our requirements. On the other hand, Shanxi has widely distributed coal resources, with coal beneath 80 percent of Shanxi's counties (prefectures), and the common people had a tradition and experience in mining coal. After implementation of contractual responsibility for output quotas, there was surplus labor in rural areas that could become involved in developing coal. All these things provided the conditions for building township and town coal mines and accelerating energy resource base area construction. It was precisely because of analysis and research based on these objective and real conditions that we suggested taking the road of combining large, medium, and small scales and moving forward with the state as well as collectives in developing coal production. Practice has proven that this route saved investments, produced quick results, and had good benefits.

By 1989, Shanxi's township and town mines had grown to more than 6,000 from 3,000-plus in 1980 and their coal output rose from 30 million tons to 113 million tons, surpassing output in the state's unified distribution coal mines in Shanxi. Output from township and town

mines now accounts for 41 percent of total coal output in Shanxi and it has become a major force in Shanxi's coal industry. The production capacity of Shanxi's township and town coal mines has grown from 30 million tons to 113 million tons and we only used a few 100 million yuan in state loans by relying mainly on the strengths of the peasants themselves and accumulation by coal mines themselves.

Township and town mines displayed their superiority and vitality during development on the one hand, but on the other hand they also revealed their defects and inadequacies, and imperfections in our policy measures. The main ones were too many mine sites, shafts that were too small, poor technical equipment, low resource recovery rates, and bad safety conditions. To deal with problems in the developing township and town coal mines, we implemented a principle that combined development with protection and simultaneous invigoration and good management to carry out rectification in township and town coal mines. The Shanxi Provincial Government established a Coal Resource Management Commission and reinforced unified management of resources. They restricted individually-run mines and encouraged jointly-run mines and made safe production in township and town coal mines the focus of transformation, rectification, and improvement of work. Production conditions were improved in many township and town coal mines.

### **III. Deal Correctly with the Relationship Between Energy Resources and Other Sectors, Promote Coordinated Development of Shanxi's Entire Economy**

In the initial stages of energy resource base area construction, a nation-wide shortage of energy resources which urgently required Shanxi to produce more coal compelled us to focus our efforts in base area construction on increasing coal production. During those few years, coal output increased very quickly but contradictions like communications and transport capacity, a weak agricultural foundation, backward light and textile industries, inadequate supplies of daily consumer goods, and so on became increasingly acute. Practice caused us to realize that the national economy was an entity and required correct industrial policies to form rational regional economic structures. As an energy resource, heavy industry, and chemical industry base area, we could not develop energy resources independently. First, there must be corresponding development of our agricultural foundation. Second, construction of other industries and other facilities must keep pace. Third, there must be coordinated development of S&T, education, and cultural activities. Fourth, there must be corresponding improvements in people's living standards. In summary, energy resource base area construction must promote stable and coordinated development of the entire Shanxi economy and should unify support for the nation with invigoration of Shanxi and bringing prosperity to the people.

Embodying this guiding ideology and starting with actual conditions in Shanxi, we suggested strategic principles for developing Shanxi's economy during the Seventh 5-Year Plan and in actual work we focused on handling the following relationships well: First was the relationship between the energy resource base area and the agricultural foundation. Agriculture is the foundation of the national economy. Without agriculture, there would be no stable foundation for the energy resource base area. Shanxi has a weak agricultural foundation and is not self-sufficient in grain, cotton, and edible oils. This is particularly true since starting energy resource base area construction, which led to continual increases in the number of construction workers and coal miners who came to Shanxi from other areas. This made the contradiction of inadequate supplies of grain and edible oils in Shanxi particularly acute. For a while, insufficient supplies of fine grains forced the outflow of coal miners who had come from other regions and affected production. For this reason, we summarized experiences and lessons, gradually straightened out the relationship between energy resources and agriculture, and expended great effort on reinforcing the fundamental status of agriculture. For the past several years, we continually increased investments in agriculture, guided governments at all levels in using capital accumulated from coal production primarily for agricultural development. Several key coal producing counties gradually formed a development path during practice of a combined coal and agricultural economy with agriculture as the foundation and coal as the pillar, mutual promotion and mutual supplementation of coal and agriculture, and coordinated and stable development that had Shanxi characteristics and was adapted to the economic characteristics of coal producing counties. Through our efforts, the present tendency to focus on coal and neglect agriculture is being reversed, grain output continues to rise, and the agricultural foundation has been strengthened. The second relationship is the one between coal production and communications and transport. As coal production has developed, the contradiction of inadequate communications and transport became increasingly acute and there were large overstocks of coal throughout Shanxi for a while. In some mountainous areas, the inability to ship out coal or agricultural and sideline products prevented them from throwing off their backward situations. The call from peasants for road building was intense. For this reason, while the state has been carrying out technical transformation of railroad trunklines in Shanxi, we began concentrating financial resources in Shanxi in 1985 to focus on railroad construction and built 13 highways to ship Shanxi's coal out of the province as well as several county and township highways and mining region highways which substantially changed the highway communications situation throughout Shanxi. Over 30 million tons of coal was shipped out by highway in 1989. Construction of five local rail lines is now underway. The contradiction of inadequate coal out-shipment capacity in Shanxi has been alleviated somewhat. The third relationship is the relationship between energy resource production and the household consumer

goods industry. Shanxi has a heavy economic structure and a weak consumer goods industry. About half of the household consumer goods Shanxi needs must be imported from other provinces. The prices for most household consumer goods have now been deregulated, but the state sets prices for most coal and raw materials products, which has led to a dual outflow of value from Shanxi that has affected the pace of invigorating the province and bringing prosperity to its people. For this reason, we have gradually focused on development of the light and textile industries in the past few years, tried to develop technical and economic cooperation with fraternal provinces and municipalities, accelerated technical transformation in existing enterprises, raised the quality grades of light industry and textile products, increased their diversity and variety, developed new products, and improved Shanxi's overall economic structure. The fourth relationship is the one between speed and benefits. Heavy industry accounts for a substantial proportion in Shanxi and its development speed is greatly restricted by capital, transportation, and raw materials supplies, so it cannot be too fast. This, our economic development has resolutely begun with reality in making an all-round effort to improve economic results instead of a speed comparable to the coastal provinces and municipalities. In coal production, we have adhered to the principle of setting production according to transport and setting output according to sales to avoid blind expansion of output. In assessing the achievements of each region and city and each department in economic construction, the main thing we have looked at was not the speed of development. Instead, it was the size of the economic benefits. Adherence to this type of guiding ideology has led to a relatively stable rate of growth in Shanxi's economy over the past few years and there have been no major fluctuations, so we have achieved sustained and stable development.

#### IV. Be Resolute in Doing Survey Research, Try To Make Democratic and Scientific Policy Decisions

For the past several years, the main reason that Shanxi's energy resource, heavy industry, and chemical industry base area construction has proceeded relatively smoothly is that every economic decision and reform program we make must undergo wide-ranging survey research and conscientious solicitation of the views of cadres and the masses in the greatest possible effort to gain a clear understanding of the causes and effects of the internal relationships of objective things, to clarify the relationship between things and the things around them, and to draw correct conclusions from this.

After the State Council decided to build Shanxi into China's energy resource, heavy industry, and chemical industry base area, to formulate good comprehensive programs for base area construction, make them conform to realities in Shanxi, and turn them into blueprints for guiding base area construction, the Shanxi Provincial CPC Committee and Shanxi Provincial Government invited more than 1,400 people from over 200 units in

and outside of Shanxi to participate in program formulation. They included leading cadres and actual workers as well as several experts and professors. This staff spent 1 year, used the scientific attitude of seeking truth from facts, did wide-ranging and intensive survey research on the history and current situation of economic development in Shanxi, collected several million pieces of data, gained a basic understanding of the situation, and drew relatively systematic and comprehensive conclusions. On this foundation, they compiled an industry plan and comprehensive program and used econometrics, technical economics, and a systematic degree of modern scientific methods, electronic computers, and other measures to compile 30 different categories and program models, carried out simulation and evaluation of different programs for base area construction, and, under the guidance by qualitative research, they did scientific quantitative analysis. After the draft programs were prepared, they carried out comprehensive debate. Because of the completeness of the survey research work, the comprehensive program for the Shanxi energy resource, heavy industry, and chemical industry base area was based on Shanxi's resource conditions and current economic situation, and it reflects the status and role of energy resource construction in Shanxi's economic development, illustrates the laws and development prospects of base area construction, and achieves the integration of central interests with local interests rather well.

The ideology of seeking truth from facts that has been advocated by comrade Mao Zedong and comrade Deng Xiaoping guides us in overcoming difficulties, doing our work well, and making continuous advances. The achievements that Shanxi has made in energy resource, heavy industry, and chemical industry base area construction depended on seeking truth from facts. In the future, even better construction of the Shanxi energy resource, heavy industry, and chemical industry base area and the magnificent undertaking of invigorating Shanxi and bringing prosperity to our people must resolutely adhere to the party's guiding ideology of seeking truth from facts.

#### Developing the Shanxi, Shaanxi, Inner Mongolia Energy Base

916B0020C Beijing GUANGMING RIBAO in Chinese  
18 Nov 90 p 2

[Article by Zhai Huisheng [5049 1920 3932]: "After an Extensive Inspection in Shanxi, Shaanxi, and Inner Mongolia, the Chinese Academy of Sciences Comprehensive Inspection Team Suggests Accelerating Construction of the "Black Gold Triangle" and "Gold Belt" Energy Resource Base Areas"]

[Text] In the next 10 years, if we scientifically develop the "black gold triangle" and "gold belt" regions of Shanxi, Shaanxi, and Inner Mongolia in a planned manner, a new energy resource base area that is enormous in scale and dominated by the coal, thermal power,

and chemical industries may be built on the loess plateau. That was the conclusion drawn by the Chinese Academy of Sciences Loess Plateau Comprehensive Scientific Inspection Team after extensive inspection and research.

The region bounded by Shanxi, Shaanxi, and Inner Mongolia has become known as the "black gold triangle" because it is extremely rich in coal resources, while the nearby area of Inner Mongolia along the Huang He has been given the laudatory title of the "gold belt" because it is near the famous Lang Shan multiple metals zone. These two regions cover an area of about 90,000 square kilometers and include 24 counties, cities, and banners. The inspection team indicated that the "black gold triangle" contains the huge Jungar, Dongsheng-Shenfu, and other world-famous coal fields. The entire region has proven coal reserves of more than 200 billion tons, 40 percent of China's total reserves, and its superior quality power coal reserves account for two-thirds of China's total. Moreover, the coal is buried at shallow depths and most of it can be extracted in strip mines. The "gold belt" has five iron sulfite, copper, lead, and zinc mineral regions. The Huang He cuts across the entire region, so there abundant water. Added to the broad, flat land along both banks of the Huang He and the developed irrigated agriculture, these provide superior conditions for building a new energy resource base area.

Experts in the inspection team feel that if no major changes occur in China's energy resource structure before the end of this century, 70 to 80 percent of China's coal will have to be supplied by the energy resource base area centered on Shanxi. However, because over 80 percent of Shanxi's coal is anthracite and coking coal, superior quality power coal will have to shift to the "black gold triangle" region and its construction scale may account for over one-third of China's

total. At the same time, to ensure that China's magnificent economic development goals are achieved by the year 2000, we must accelerate development of our electric power industry. Although coal can be hauled from the energy resource base area to coastal regions to generate power, this is restricted by the high cost of railroad and port construction, population density, serious pollution, and other factors. This is not nearly as good as developing power generation in areas in the energy resource base area that are near coal and water sources and where sites are available. If several huge thermal power plant clusters were deployed in the "black gold triangle" and "gold belt" regions, they could form China's biggest thermal power plant chain with a total installed generating capacity scale of 60,000MW, which is 5 to 6 times as much electric power as the Three Gorges project could transmit to east China.

The experts point out that to release the potential of the "black gold triangle" and "gold belt" regions as quickly as possible, we must make appropriate readjustments in spatial construction policies which "favor the east" during the Eighth 5-Year Plan and Ninth 5-Year Plan. Investments in energy resources and high energy consuming industries should be transferred to areas of central and western China, areas with rich concentrations of energy resources and raw materials resources. Since the "black gold triangle" is the region of China with the most severe soil erosion, we definitely cannot take the old route of "developing first, improving later". We must include work to improve the environment in development plans, designs, investments, construction, examination and acceptance, and legal supervision from start to finish and achieve simultaneous development and improvement. Moreover, we should coordinate well the contradictions among the interests of production and transportation, resource, processing added value, grain and sideline product supplying, and other regions.

### Natural Gas-Diesel Dual-Fuel Engine

916B0026 Chengdu TIANRANQI GONGYE  
[NATURAL GAS INDUSTRY] in Chinese Vol 10, No 6,  
25 Nov 90 pp 84-86

[Article by He Jiangchuan [0149 3068 1557] of the Sichuan Petroleum Management Bureau's Nanchong Petroleum Machinery Plant]

[Abstract] This article describes the methods used to refit a diesel engine into a natural gas-diesel dual-fuel engine [DFE], refitting different engine models. The engine, a compression ignition type, can be fueled solely by diesel or by natural gas, but the latter requires injecting a small amount of diesel (about 15 to 20 percent) for ignition. It can be refitted from a diesel engine or designed and manufactured. The engine can switch from diesel to dual-fuel operation and back in just a few seconds without affecting engine output power. Refitting is done simply by adding a gas fuel supply system and fuel switching device.

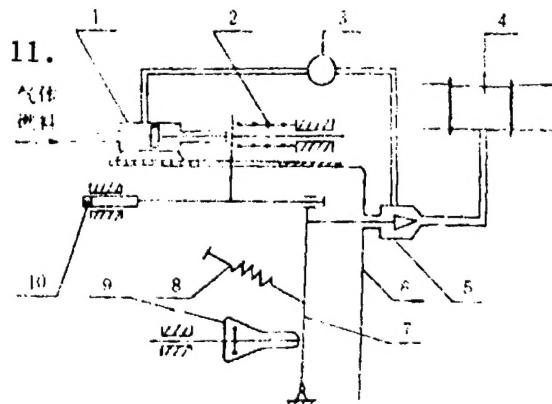
The engine's maximum power, torque, speed governing performance, exhaust, etc. differ for the two types of operation. The key factors controlling engine power during dual-fuel operation are the gas mixture concentration and anti-knock properties of the gas fuel. Increases in output power are limited by knocking due to the higher compression of the DFE (usually above 15), so the methane value of the gas fuel anti-knock combustibility determines engine power limits when burning gas. Maximum power using natural gas with 90 percent CH<sub>4</sub> (methane value 90) can exceed 95 percent of the maximum power of the diesel engine.

When the DFE is running, natural gas and air are mixed evenly and the gas mixture is fully combusted. Much less smoke and toxic gases are generated compared to diesel, the CO and NO<sub>x</sub> content in the exhaust is negligible, and the SO<sub>2</sub> content of the exhaust gas can be ignored when using desulfurized natural gas. Thus, environmental pollution is greatly reduced.

The amount of oil ignited, injection time, etc. also affect engine performance during dual-fuel operation to varying degrees.

A natural air intake diesel engine can be refitted into a DFE by slight refitting of the original speed governor and high-pressure oil pump, adding a natural gas control valve (governor valve), mixer, etc. The amount of natural gas entering the mixer is determined by the openness of the governing valve and the position of the oil feed rack is restricted to the amount of oil required for ignition. The mixer is added to eliminate non-homogeneity in the gas mixture. A pressure stabilization piston should be installed on the natural gas intake pipe when there are relatively large fluctuations in natural gas pressure.

Refitting a pressurized diesel engine is basically the same, but this type of engine has a larger air valve overlap and stronger gas sweeping action. The gas fuel is fed only after the gas exhaust valve closes to prevent its combustion inside the exhaust system due to gas being swept into the exhaust pipe or backflow of the gas fuel. Thus, independent natural gas control valves are installed on each gas intake branch pipe and can be controlled by the gas valve thrust lever. Consideration also should be given to matching and knock vibration problems in the pressurizer and engine during gas fuel operation. The oil spray pump and oil sprayer used in the diesel engine are eliminated and replaced with a distributor plate, spark plug, and modified pressure combustion ignition arrangement. This engine can use gas fuel but not diesel after refitting. Refitting changes several structural parameters of the original diesel engine, is expensive, and would be difficult for non-specialized plants.



**Refitting of a Natural Gas-Diesel Dual-Fuel Engine**  
Key: 1. Pneumatic piston 2. Spring to regulate amount of ignition oil 3. Pressure regulation valve 4. Mixer 5. Natural gas control valve (governing valve) 6. Outer casing of governor 7. Governing lever 8. Governing spring 9. Governor flying iron 10. Fuel feed rack 11. Gas fuel

Refitting diesel engines used for different purposes:

1. Diesel engines used for power generation. These engines operate at stable loads and usually at fixed rotation speeds, so they have rather stringent governor performance requirements which can be met by correct design of the shape of the natural gas control valves and selection of rational control valve travel.
2. Diesel engines used on drill rigs. Substantial changes in strata conditions and frequent changes in engine loads require these engines to have excellent dynamic properties during dual-fuel operation. The dynamic properties using the regular refitting program can surpass or equal the original diesel engine during low and moderate range speeds, but they are slightly lower during the high speed

range because the gas mixture concentration in this range is lower than the maximum power gas mixture. Adding a concentration device to spray some natural gas in the high speed range to change the concentration of the gas mixture can fully satisfy working requirements during dual-fuel operation.

3. Diesel engines used in vehicles. These engines have a wider range of operating conditions, and thus must have better dynamic properties, excellent starting and idling properties, and rather high thermal efficiency to ensure continuous driving mileage. A compressed natural gas tank, pressure reduction valves, and so on must be installed on the vehicle, so refitting is difficult and rather expensive.

The natural gas used in the DFE must be desulfurized. Otherwise, the useful life of the engine will be greatly reduced.

Expected fuel savings from adopting the DFE in China's petroleum industry could be substantial. Many local enterprises can also use methane, coal gas, and so on in the DFE. Refitting a natural air intake diesel engine costs a few 1,000 yuan. The cost is almost 10,000 yuan for a pressurized diesel engine. Users will also have to add some needed equipment and safety features, so the cost may be about 10 percent higher than a diesel engine. Estimates indicate that the investment can be recovered in 2 to 3 years from reduced fuel costs.

### Joint Sino-Soviet Effort to Develop Heilong Jiang Hydropower

916B0036C Beijing LIAOWANG [OUTLOOK]  
in Chinese No 2, 14 Jan 91 p 22

[Article by Zhang Ling [4545 0407]: "China and Soviet Union Join Hands To Develop Heilong Jiang Hydropower Resources"]

[Text] In 1986, representatives of the Chinese and Soviet governments signed the "Agreement Between the Governments of the People's Republic of China and Union of Soviet Socialist Republics Concerning the Establishment of a Sino-Soviet Committee To Direct the Formulation of a Comprehensive Utilization Program for the Hydropower Resources of the Ergune River and Heilongjiang Border River". This opened a new page on cooperative surveys, planning, and comprehensive utilization of the water resources of Heilong Jiang. Chinese and Soviet experts have now completed their survey work and are entering the planning and design phase.

The Heilong Jiang has a distant source and flows for a long distance. Its southern source, the Ergune River, flows out of the Hentiy Nuruu Range inside the People's Republic of Mongolia, while its northern source, the Silka River, is inside the Soviet Union. The southern and northern sources surge toward the place where they join near the Luogu He and then from the Luogu He to the Tatar Strait, where it flows into the sea, extending over a total length of 4,300 kilometers. The upper reaches run from Luogu Village to Heihe City (the mouth of the Zeya He). The middle reaches lie between Heihe City and Fuyuan (the mouth of the Wusuli Jiang). The lower reaches lie between the Wusuli Jiang and the mouth at the sea. The upper and middle reaches along with the tributaries the Ergune River and Wusuli Jiang comprise the Sino-Soviet boundary river. The river basin covers a total area of more than 1.84 million square kilometers and includes parts of China, the Soviet Union, and Mongolia. The section of the river which flows through China covers 900,000 square kilometers.

Not long ago, travelling eastward along the Ergune River, I saw only clear river water swirling in the narrow mountain gorges of the Da Hinganling between the cliffs on either bank. Dark brown granite, sandstone, and other outcrops were visible among the white birch forests and larches. This was the unique charm of the upper reaches of the Heilong Jiang. I travelled by boat to the location of the 69 kilometer navigation marker but saw only surging river waters 400 meters wide and steep cliff walls rising over 100 meters on both banks.

Wang Changxiang [3769 7022 4382], deputy director of the Heilongjiang Provincial Water Conservancy Department, told me that this was the most ideal site for a key water conservancy project on the trunk of the Heilong Jiang. A big 124 meter high and 1,350 meter long dam stretching across this site could generate 6 billion kWh of electricity.

Expert colleagues also said that Taiping Ravine (the middle and upper reaches) on the trunk of the Heilong Jiang between Luogu He and Luobei has a natural head of more than 270 meters and hydropower reserves of 8,600 to 10,000MW, with 4,200MW of it in China.

The rich hydraulic resources are undoubtedly a huge latent motive force for economic development along both banks of the river. On the Chinese side lie the four prefectures of Da Hinganling, Heihe, Yichun, and Jiamusi, 14 counties, 12 state farms, five forestry bureaus, 22 forests, a population of 600,000, and 6 million mu of cultivated land. There are rich reserves of resources here. The forested area accounts for about one-eighth of China's total. It holds third place in China in gold reserves and first place in placer gold reserves. It holds eighth place in China in available copper ore reserves. However, about 30 percent of its production capacity cannot be used because of the energy shortage and economic development is severely restricted. The situation is roughly the same on the Soviet side.

For these reasons, China and the Soviet Union conducted a cooperative survey of the Heilong Jiang back in the 1950's and both countries signed the "Agreement on a Joint Survey of Natural Resources in the Heilong Jiang Basin, Long-Term Scientific Research Work on Developing Forces of Production, and Survey and Design Work for Planning Comprehensive Utilization of the Upper Reaches of the Heilong Jiang" and prepared preliminary plans for an installed generating capacity of 8,000MW and yearly power output of 27 billion kWh. This electric power is equivalent to about 8 million tons of standard coal. However, for various historical reasons, this cooperation was interrupted for several decades. Now, with the restoration of normal relations between both sides, a new page has been opened on cooperative development of the resources of the Heilong Jiang.

Heilongjiang Provincial governor Shao Jihui [6730 1142 1920] said that energy resources are the foundation of economic construction and economic development. Comprehensive development and utilization of the Heilong Jiang is now urgent. When deciding on development strategies for the Heilong Jiang, besides focusing on consideration of hydropower, water conservancy, transportation, fishery, ecology, and environmental protection on the Heilong Jiang itself, there should also be systematic and comprehensive research on agriculture, forestry, gold mining, and border trade ports in the Heilong Jiang basin. The Heilong Jiang will no longer be asleep and the surging river will no longer flow away unused. It will bring prosperity to the people on both banks.

### Achieving Target of 80,000MW Installed Capacity by Year 2000

916B0034 Beijing SHUILI FADIAN [WATER POWER] in Chinese, No 1, 12 Jan 91 pp 2-3, 10

[Article by Chinese Society for Hydroelectric Power Engineering: "Proposals for Achieving 80,000MW in Installed Hydropower Generating Capacity by the Year 2000"]

[Text] The 3d Members Congress of the Chinese Society for Hydroelectric Power Engineering was held in Wuchang during the last third of March 1990. All delegates were extremely concerned with and conscientiously discussed the current situation in hydropower construction in China and felt that the problems were extremely serious. Given the strategic deployments for quadrupling our GNP by the year 2000, total coal output in China must reach 1.4 billion tons in 2000, an increase of nearly 400 million tons over yearly output in 1989, which is an extremely arduous task. The electric power installed generating capacity must surpass 240,000MW, so we must add over 110,000MW in the next 10 years, which is an especially arduous task. About half of the additional 400 million tons of coal will be used to generate electricity, and we will be able to increase thermal power by 65,000MW at the most (assuming that there are no problems with coal transport). There will also be 5,000MW of nuclear power placed into operation, so the remaining 40,000MW-plus must rely on hydropower. There is no other way. This means that over the next 10 years we must complete more hydropower construction tasks than we have over the past 40 years. We must place an average of 4,000 to 5,000MW into operation each year, which is 3 to 4 times the average annual capacity placed into operation during the Seventh 5-Year Plan, so the tasks are extremely urgent and arduous. Since China has extremely abundant hydropower resources and powerful hydropower construction staffs and equipment manufacturing and installation capabilities, there is great potential and it is entirely possible for us to complete the tasks. However, given the fact that only 73 percent of the hydropower generator installation plans for the Seventh 5-Year Plan were completed, if we do not start now in adopting powerful measures in the areas of systems, investments, policies, and so on, it will be impossible for us to complete such difficult tasks, which will directly affect China's overall goals for economic construction. We are extremely worried by this, so we have sent a special report to the State Council on problems that exist at present and offered our proposals.

### I. The Main Problems in Hydropower Construction at Present

#### A. The hydropower management system is incomplete

The Ministry of Energy Resources and Ministry of Water Resources are the state organs responsible for managing hydropower development. The investment area includes the Energy Resource Investment Company and the Huayeng Company. The Central Water Conservancy and Hydropower Planning and Design Academy, which is responsible for inspecting river basin plans and engineering projects, is under the dual jurisdiction of the Ministry of Energy Resources and Ministry of Water Resources, so their forces are scattered and even become mutual impediments. There is even less management of long-term macro plans. Projects which concern boundary rivers that cross over different administrative

regions, projects to supply electricity to adjacent provinces and autonomous regions, and projects which lead to conflicts between the overall and local situations or between departments lack effective organizational coordination relationships. Projects which submit reports to the State Planning Commission also cannot be submitted because of a lack of unanimity of views. There are a multitude of problems in arranging tasks, readjusting forces, self-construction, and so on in basic level design academies and engineering bureaus. There are several 10,000 people idle in our construction staffs because of insufficient hydropower construction tasks. They face many difficulties and find it hard to continue. Some employees have seen their incomes decline and their standards of living fall. People are uneasy.

#### B. The investment system is irrational, there is a serious shortage of investments in hydropower

Since 1980, investments in capital construction in the electric power industry have come mainly from central authorities. Investments in hydropower construction account for about one-third of capital construction investments in the electric power industry. Investments by central authorities are the main source for hydropower. Local areas have definite enthusiasm and they have implemented the principle of developing power by many parties over the past several years. State budgets and bank loans account for only about 30 percent of total investments in electric power. They have also relied on local capital raising and selling rights to purchase and use electricity to users, issuing electric power bonds, borrowing foreign capital, and so on to solve the problem. After diversification of investment sources, development of the electric power industry was accelerated and there was substantial development of thermal power and local small-scale hydropower. Major problems occurred, however, at large and medium-sized key hydropower stations. Investments in hydropower construction as a proportion of total investments in electric power dropped from 35 percent in the Fourth 5-Year Plan and 34.3 percent in the Fifth 5-Year Plan to 18 percent in 1989 (the 1990 plan is 17 percent). Because investments were too small and projects under construction could not be arranged according to rational construction schedules, only an estimated 73 percent of the plan for installed generating capacity will be completed during the Seventh 5-Year Plan and no new project construction will begin during 1990. Construction of the reserve projects at Ertan and Tianshengqiao first cascade hydropower stations will not start because investments have not been implemented. Only about 3 to 4 billion yuan is now being invested in hydropower projects each year, but we will have to invest an average of at least 9 billion yuan a year over the next decade. If the investment situation does not change, there actually will be no way to achieve the Eighth 5-Year Plan and Ninth 5-Year Plan.

Why is it hard now to raise capital for hydropower? The basic problem is that our current investment system is irrational and the direction of investments does not

conform to the overall economic interests of the state. For our overall national situation, the total investment and construction schedules for thermal power plants along with coal mine and transportation projects are about the same as or exceed those of hydropower stations of equivalent scale, while their operating costs far exceed those of hydropower stations. However, since the nation was founded, investments in thermal power plants have been listed under electric power, construction investments for the coal burned for thermal power have been listed under coal, and investments in coal transportation have been listed under communications, which is the same as three parties investing in thermal power construction. Hydropower construction, however, must rely on investments in hydropower stations themselves and they must assume the burden of investments in flood prevention, water-borne transport, irrigation, and other aspects of comprehensive utilization. In this type of situation, electric power departments, local areas, banks, and investment companies are unwilling to or find it hard to invest in hydropower. Even areas with hydropower resources and no coal develop more thermal power, and the reason is very clear.

#### C. Insufficient funds for preparatory work

There must be sufficient design reserves to meet the hydropower construction requirements of the Eighth 5-Year Plan and Ninth 5-Year Plan and afterward, and preparations must be made early. Insufficient funds for preparatory work have severely affected survey, design, and scientific research work, and design reserves are seriously inadequate. Calculated on the basis of tasks, about 200 million yuan will have to be spent on preparatory work each year in the future. The state now provides only 85 million yuan, so there will be a shortage of more than 100 million yuan.

#### D. Several existing financial, taxation, price, and other systems are extremely unfavorable for hydropower construction, and some legal systems are incomplete

Hydropower involves simultaneous development of primary and secondary energy resources, but it does not enjoy the preferential treatment given to primary energy resources. Instead, it is subject to pressures from high interest rates, high tax rates, and a multitude of taxes. The electric power that hydropower supplies to grids has a low price and no distinction is made between peak load and basic load electricity prices, so hydropower has lost the capacity to repay loans. Water resources and hydropower are inseparable, and it is irrational as well for cultivated land occupation taxes to be collected for hydropower.

If these problems are not resolved quickly, we feel that hydropower construction plans for the next 10 years will fall through, which will have profoundly negative effects on future development of the national economy.

## II. Proposals

A. Because hydropower is a renewable and clean energy resource, and can conserve our limited mineral fuels and reduce environmental pollution, the state should make major efforts to develop hydropower and improve our energy resource structure a basic national policy, unify understandings, and adopt the corresponding measures. We propose that, with support by the State Planning Commission, with the Ministry of Energy Resources as the main force, and with participation by the relevant departments and local areas, we should rapidly carry out a comprehensive balance of coal, power, and transportation divided by region and time periods based on the needs of China's national economy and electric power development, resource distribution conditions, and the state's financial and material conditions, and use the state's optimum economic benefits as a standard for formulating unified construction plans and deployments for hydropower, thermal power, and nuclear power plants. After the state approves these unified programs and plans, they should be transmitted to lower units as directive plans and the relevant departments and local areas must guarantee their implementation. We propose that the state give permission for construction to begin at several large construction projects where the conditions are already mature, such as Ertan, Tianshengqiao first cascade, Longtan, Shisanling, Tianhuangping pumped-storage, and other power plants. Investments should be guaranteed and construction should be guaranteed according to rational construction schedules for projects under construction like Lijia Gorge, Baozhusi, and so on. Projects which have the proper conditions to begin construction like Heishan Gorge, Wanjiazhai, and so on should quickly coordinate views between provinces and autonomous regions and between departments to begin construction as soon as possible.

B. Solve the problem of capital sources for hydropower. The state should make fulfillment of the capital necessary for hydropower development a major energy resource construction policy. It should readjust electricity prices or increase requisitions for a hydropower construction fund to centralize some capital as appropriate for building key hydropower stations, and it should adopt various measures and stipulations or encourage local areas and investment departments to invest in hydropower to enable them to raise the capital they need according to approved construction plans, arrange for construction according to rational construction schedules, and guarantee their completion.

C. Support should be provided to hydropower in policy areas like finance, taxation, electricity prices, and so on. We should first provide hydropower with preferential policies for loan interest rates, tax rates, and loan repayment periods like those for petroleum, coal, and other primary energy resources and eliminate several types of unreasonable taxes like the cultivated land occupation tax. Legislation should be established for land requisition and population resettlement policies in reservoir regions. For electricity prices, we should implement new

prices for new electricity, set the price for peak electricity higher than base load electricity and the price for hydropower during wet periods lower than the price for hydropower during dry periods so that users can buy more hydropower while at the same time conserving coal burned for thermal power, which will also benefit the electric power system.

D. Gradually reform and perfect the hydropower development management system. Use various arrangements to develop hydropower according to the conditions in each area. We propose extending the implementation of the model of river basin or regional hydropower development companies, with the state providing preferential policies, startup capital, and administrative authority to enable them to truly assume responsibility for construction tasks for large and medium-sized river basin or regional hydropower, take the route of benevolent cycles that use hydropower to develop hydropower, rolling management, and self-development, and request that state planning, financial, and trade departments provide substantial support. Central administrative departments should truly strengthen and improve their organization, leadership, and management of hydropower, quickly and effectively promote development construction and administrative management of hydropower, and reverse the present situation of passivity and hesitation. Hydroelectric power generation is an important part of energy resources and electric power as well as an important aspect of river control and development which involve administration by both the Ministry of Energy Resources and the Ministry of Water Resources. We propose that the State Planning Commission reinforce comprehensive coordination and further smooth out relationships.

E. Speed up preparatory work, reinforce self-construction in hydropower staffs. We propose that the state increase funds for preparatory work. To face the challenge of difficult tasks, hydropower staffs should summarize experiences and lessons from the past, improve the quality of hydropower staffs, improve construction management and operational management, and increase economic benefits.

We believe that after reforms perfect and straighten out the relevant system relationships and policies, hydropower construction staffs, which have a glorious tradition covering 40 years of arduous struggle, will victoriously complete the magnificent tasks of increasing the installed hydropower generating capacity by more than 40,000MW over the next 10 years and attaining a total installed hydropower generating capacity of 80,000MW by the year 2000.

#### **Improving the Energy Structure by Accelerating Hydropower Development**

916B0030A Beijing SHUILI FADIAN [WATER POWER] in Chinese No 12, 12 Dec 90 pp 9-13, 5

[Article by Zhu Ermeng [2612 1422 2494], president of the Central Water Resources and Hydropower Planning

and Design Academy in the Ministry of Energy Resources and Ministry of Water Resources; "Accelerate Development of Hydropower, Improve the Energy Structure—Ideas for a 10-Year Development Plan for Hydropower Construction"]

[Text] Energy resources are an important material foundation of social development and a strategic focus of socialist economic construction. In view of the characteristics of China's energy resources and the current energy resource industry structure, energy development should be centered on electric power with coal as the foundation, and there should be major efforts to develop hydropower, actively develop nuclear power, and actively develop petroleum and natural gas.

China has abundant hydropower resources and holds first place in the world in reserves with developable amounts that account for about 35 percent of China's primary energy resources. Hydropower is a renewable and clean primary energy resource. Accelerated development of hydropower can improve the energy resource structure and conserve mineral resources, and it can promote control of rivers and full foster the benefits of comprehensive utilization of water resources. It is an important way to solve coal, power, and communications and transportation shortages and reduce environmental pollution. It is one of the basic strategies for the development of China's energy resource industry. Thus, accelerating hydropower construction should be a basic principle for China's energy resource industry and river control during the Eighth 5-Year Plan and the 10-year development plan. I will now offer some views on the current situation in hydropower construction and problems that exist, the principles and goals in compilation of the Eighth 5-Year Plan for hydropower construction and a 10-year development plan, the foci and deployments for hydropower construction over the next 10 years, the policies and measures that should be adopted, and so on.

#### **I. The Current Situation and Problems**

##### **A. The current situation in China's hydropower construction**

Hydropower construction has developed rather quickly in China in the 40 years since our nation was founded and we have made substantial achievements. China's installed hydropower generating capacity in 1949 was only 162MW and we generated 710 million kWh of power annually. Our installed hydropower generating capacity had grown to 34,580MW by 1989, with yearly power output of 118.5 billion kWh. As a proportion of the electric power industry, these figures grew from 8.8 percent to 27.3 percent and from 16.5 percent to 20.2 percent, respectively. Shortly after our nation was founded, China held 25th place in the world in installed hydropower generating capacity and 23d place in power output. We have risen to 6th and 5th place, respectively. Over the past 40 years, hydropower produced a total of 1,409.7 billion kWh of power and the taxes and profits realized long ago exceeded the total investments

arranged by the state. Hydropower construction has increased our reservoir regulation and storage capacity and reduced the threat of flooding in downstream cities and towns. It has expanded the area of farmland irrigation, increased grain output, improved water-borne shipping conditions, developed tourism, aquatic breeding, and other activities, and promoted regional economic development. The scale of large and medium-sized hydropower stations now under construction is about 18,500MW.

#### B. Problems that exist in hydropower construction

##### 1. A low degree of development, irrational structure of production

Hydropower has advantages like being inexpensive, renewable, and clean and it has usually been given preference in development in foreign countries. The average development and utilization level in the world at present is 13.5 percent (based on power output). It exceeds 50 percent in the economically developed nations and is nearly 20 percent in developing nations like Brazil, India, and so on, but the level in China is just 6 percent. China's hydropower resources account for 35 percent of our primary energy resources but only about 5 percent of our structure of energy resource production. This irrational structure of energy resource production restricts economic development.

##### 2. A declining proportion of hydropower year after year

First, investments in hydropower construction as a proportion of total investments in electric power were 35 percent during the Fourth 5-Year Plan and 34.3 percent during the Fifth 5-Year Plan, but fell to 27.4 percent during the Sixth 5-Year Plan and will drop to 18.9 percent during the Seventh 5-Year Plan (the forecast for 1990 is 17 percent). Because investments in hydropower have been insufficient, hydropower projects under construction cannot be built according to rational construction schedules and cannot go into operation as planned. Construction of new projects cannot begin on time, the scale of hydropower under construction has shrunken, and reserve strengths are inadequate.

Second, within the electric power industry, new additions to installed generating capacity at large and medium-sized hydropower stations accounted for 27.6 percent during the Fourth 5-Year Plan, 17.7 percent during the Fifth 5-Year Plan, and 19.4 percent during the Sixth 5-Year Plan, and are expected to be 15.7 percent during the Seventh 5-Year Plan. Plans during the Seventh 5-Year Plan call for an increase of 8,120MW, but we expect to actually complete just 6,000MW, only 73 percent of the plan.

Third, installed hydropower generating capacity as a proportion of the total installed electric power generating capacity dropped from 30.9 percent at the end of the Fourth 5-Year Plan and 30.8 percent at the end of the Fifth 5-Year Plan to 30.3 percent at the end of the Sixth 5-Year Plan and is expected to be just 27.3 percent at the

end of the Seventh 5-Year Plan. Yearly power output from hydropower dropped from 24 percent in the latter part of the Fourth 5-Year Plan to 19.4 percent in 1989. The annual growth rate in new additions to installed generating capacity in hydropower construction fell from an average of 16.8 percent prior to 1980 to between 5 and 6 percent during the Sixth 5-Year Plan and Seventh 5-Year Plan.

##### 3. Current related policies and measures are ineffective

Like development of petroleum and coal, development of hydropower resources involves long construction schedules and large investments, and it requires fighting floodwater and more difficult construction conditions, but certain current policies are unfavorable to the development of hydropower. First, the interest rate on loans for hydropower are different from petroleum and coal, but are like those for thermal power (a secondary energy resource) with high interest rates and short repayment periods. Second, because hydropower stations are not independent accounting units and are instead under unified accounting for hydropower and thermal power by electric power bureaus, the price for power supplied to grids by hydropower is low and no distinction is made between prices for peak and valley power, so although the costs of hydropower are just one-third those of thermal power, its input/output benefits are not reflected. On the one hand, hydropower lacks independent capital channels and the conditions for self-development. On the other hand, the state has not implemented investment shares for hydropower projects with comprehensive benefits or benefit repayment policies and measures, which has led to additional increases in hydropower investments and raised costs. Third, the cost of compensation for reservoir inundation continues to rise and population resettlement arrangements are becoming increasingly difficult. Hydropower projects involving two provinces (autonomous regions) present definite problems for project planning and design because there are no policies or measures for investment and benefit sharing. Fourth, besides the benefits from generating power, hydropower projects usually have additional comprehensive utilization benefits in flood prevention, irrigation, water-borne shipping, water supplies, and other areas, but in the area of profits and taxes hydropower must also assume the burden of cultivated land occupation taxes and is not exempted from cultivated land occupation taxes like water conservancy, airports, highways, and so on. This creates new burdens for hydropower construction, which was already short of capital. Thus, in terms of investment, taxation, and systems, the existing related policies and measures do not benefit the development of hydropower construction.

##### 4. Preparatory funds are seriously inadequate, design project reserves are too small

The development of hydropower and full utilization of hydropower resources requires stable long-term preparatory work expenditures to guarantee the required design

project reserves. Still, with rising materials prices in recent years, the state has not increased preparatory expenditures for survey, design, and scientific research. Instead, state control over business expenditures has been reduced each year, so there are too few design reserve projects. The extent of planning, survey, design, and testing work is not sufficient at many projects because of a lack of funds, so the quality of planning and design documents is low, which has also affected project comparison and selection work. Without attention to this problem and changes, when construction capital and policies are implemented, preparatory work for hydropower will become a factor that restricts major efforts to develop hydropower.

## II. Planning Principles and Goals

The Ministry of Energy Resources' 20-Year Electric Power Development Program points out that the electric power industry must be quadrupled between 1980 and 2000 to reach 24,000MW in installed electric power generators and yearly power output of 1,200 billion kWh. The proportion of installed hydropower generating capacity must reach 30 percent and yearly power output from hydropower 20 percent. Based on this overall requirement, we think the main principles and goals for the 10-year hydropower development plan should be as follows.

### A. Primary principles of development plans

We think the main principles for hydropower development plans over the next 10 years should be: 1) Major efforts to accelerate hydropower development should be the basic strategy for electric power industry construction for a substantial period of time into the future. 2) Give preference to the development of hydropower, strive to achieve the goal of quadrupling by the year 2000, sustain an installed hydropower generating capacity of 30 percent and yearly power output of 20 percent in the electric power industry. 3) Integrate with flood prevention, irrigation, water-borne transport, water supplies, and so on, and integrate with regional economic development to foster the comprehensive utilization benefits of hydropower resources. 4) Adapt to local conditions and integrate large, medium, and small scales. We should select several large hydropower stations with outstanding economic benefits in our 12 hydropower base areas as a key force and gradually arrange to begin construction. We should push forward with construction of several medium-sized power stations with superior economic indices and good construction conditions in regions with load shortages, and we should actively help local areas build more medium-sized and small hydropower stations. 5) Conscientiously do good river basin (river section) planning and implement continuous development of cascade power stations in river basins (river sections) with the proper conditions. 6) Actively develop pumped-storage power stations in regions with rapidly developing industry, a large proportion of thermal power, weak peak regulation capacity, and few hydropower resources. 7) In regions

with a larger proportion of hydropower, give preference to construction of key hydropower stations with substantial capacity, rather good reservoir regulation capabilities, and limited inundation losses. 8) In economically developed regions of east China with energy resource shortages, limited land, and large populations, we should carry out intensive development of hydropower resources and study rebuilding, expansion, and renewal of existing hydropower stations, build low-head hydropower stations, and actively study development of tidal energy in coastal areas. 9) We should reinforce preparatory work for construction projects, do good planning, survey, design, scientific research, and experiment work, increase design reserves, and attain a ratio of 4:2:1 for feasibility research, preliminary design, and projects under construction. We should ensure a specific number of design reserve and construction preparation projects and adapt development plans and programs to changing conditions.

### B. Main indices of development plans

On the basis of the planning principles outlined above and the overall need to double hydropower over the next 10 years, these should be the main indices for hydropower planning over the next decade:

#### 1. Scale of construction starts

An estimated scale of 18,500MW will be turned over at the end of 1990 (larger than 100MW). We should begin construction of 24,400MW in large, medium, and small-scale hydropower installed generating capacity larger than 100MW during the Eighth 5-Year Plan (1990-1995). We should start construction of 26,000MW in large and medium-sized installed hydropower generating capacity larger than 100MW during the Ninth 5-Year Plan (1995-2000). The idea for the 10-year plan is to begin construction of 50,400MW.

Because large-scale hydropower concerns rather complex social and economic relationships and taking into consideration arrangements for preparatory work and motivating initiative in all areas, we also propose arranging 8,700MW in reserve projects. We also should build about 10,000MW in medium and small-scale hydropower stations smaller than 100MW.

#### 2. Increases in installed generating capacity

The installed hydropower generating capacity at the end of 1990 is expected to reach 35,500MW. According to rational construction schedules arranged for projects under construction, we plan to add 15,000MW in new installed generating capacity during the Eighth 5-Year Plan and expect to add 27,500MW in new installed generating capacity during the Ninth 5-Year Plan, so 42,500MW in new installed generating capacity will be added over 10 years (including 5,600MW in pumped-storage power stations). This will include 34,000MW in power stations larger than 100MW. The installed hydropower generating capacity is expected to reach

78,000MW in 2000, equal to 32 percent of the total installed generating capacity.

### 3. Yearly power output

Expected yearly power output from hydropower during 1990 is 116.6 billion kWh. Yearly power output from hydropower in 1995 is expected to reach 158 billion kWh. The idea is for yearly power output from hydropower to reach 233 billion kWh in 2000, equal to 19.4 percent of total power output.

## III. Planning Foci and Deployments

China has a vast territory, a huge population, and unevenly distributed energy resources. About two-thirds of our coal resources are concentrated in Shanxi and Inner Mongolia in north China, while two-thirds of our hydropower resources are concentrated in southwest China, 90 percent of it west of the Jing-Guang [Beijing-Guangdong] Railroad. However, about 70 percent of our total value of industrial output comes from the eastern coastal region, forming a configuration of "sending coal from north to south China" and "transmitting power from west to east China". China has 378,000MW in developable hydropower resources, but because of restrictions by natural conditions, load levels, and economic conditions, it will be hard to develop and utilize part of our developable hydropower resources for a rather long time to come. Thus, the focus of hydropower development in the near term should be placed on rivers with abundant hydropower resources and good development conditions like the middle and upper reaches of the Huang He, middle and lower reaches of the trunk and tributaries of the Chang Jiang, middle and lower reaches of the Hongshui He and Lancang Jiang, and so on. We propose the following deployment of site selections for the 10-year hydropower construction plan:

### 1. Accelerate development of the Hongshui He and Lancang Jiang, transmit electric power eastward to south China

To solve the power shortage of Guangdong, it would be most economically rational to accelerate development of the Hongshui He and Lancang Jiang to transmit electric power eastward to south China. Thus, besides building the Tianshengqiao second cascade and Yantan hydropower stations on the Hongshui He, we propose building the Tianshengqiao first cascade and Longtan hydropower stations during the Eighth 5-Year Plan and new construction of the Dateng Gorge key water conservancy project during the Ninth 5-Year Plan. Besides building Manwan hydropower station on the Lancang Jiang, we also should build Dachaoshan hydropower station during the Eighth 5-Year Plan and Xiaowan hydropower station during the Ninth 5-Year Plan. The scale of new construction starts over 10 years is about 12,000MW.

### 2. Accelerate continued development of cascade power stations on the Wu Jiang

Cascade hydropower stations on the Wu Jiang are well situated. Besides meeting demand for electricity in Guizhou, they also could transmit power eastward to Hunan and northward to east Sichuan and Chongqing. They would also have other comprehensive benefits. Moreover, preparatory work is rather extensive and the conditions exist for accelerating sustained development. Thus, beside Dongfeng and Puding hydropower stations now under construction, we also should build Hongjiadu hydropower station and try to start construction of Silin hydropower station during the Eighth 5-Year Plan and plan on building Goupitan and Pengshui hydropower stations during the Ninth 5-Year Plan. The scale of new construction starts over 10 years would be about 5,000MW.

### 3. Continue to develop Dadu He and Yarlong Jiang, prepare to develop the Jinsha Jiang

After building Tongjiezi on the Dadu He and Ertan on the Yarlong Jiang, we should build Baobugou power station during the Eighth 5-Year Plan. This power station would have a reservoir with less than year-round regulation, and it is one of only a few large-scale hydropower stations with rather good regulation properties in Sichuan. Besides the very good power generation benefits of the power station itself, it could also reduce flow rates during peak flooding downstream, reduce silt accumulation, guarantee normal safe operation of Longzui power station and the Cheng-Kun [Chengdu-Kunming] Railroad, increase guaranteed output from already-built power stations by 215MW, and generate 800 million kWh of power annually. Tongyulin and the first phase of the second cascade at Jinbing on the Yarlong Jiang should be built during the Ninth 5-Year Plan. The Jinsha Jiang is a river having the most concentrated and most superior hydraulic resources and preparatory work should be done on Xiangjiaba, Xiluodu, and other hydropower stations in the near term and the best of them selected as a reserve project. The scale of new construction starts over 10 years would be about 5,700MW.

### 4. Accelerate construction of the hydropower base area in western Hunan and Hubei

Hunan and Hubei have few coal resources but are relatively rich in hydropower resources, so it would be best to accelerate development of the Xiang Shui, Zi Shui, Yuan Shui, Li Shui, Han Jiang, and Qing Jiang. Besides Wuqiangxi and Geheyuan hydropower stations now under construction, we should plan on building Shuibuya, Fankou, Jiangya, Sanbanxi, and other hydropower stations during the Eighth 5-Year Plan and Ninth 5-Year Plan. The Three Gorges project would have enormous comprehensive benefits, both for long-term state planning and for the urgency of flood prevention, power generation, and water-borne transport, so the Three Gorges project should be built. We should focus on doing preparatory work well to enable the state to make a decision.

5. Actively carry out construction of hydropower stations on the middle and upper reaches of the Huang He

There is solid survey and design work for cascade hydropower stations on the upper reaches of the Huang He and the technical economics indices are superior. Lijia Gorge and Daxia hydropower stations are now under construction. After Lijia Gorge, we should arrange for construction of Heishan Gorge, Gongpa Gorge (or Laxiwa), and other power stations during the 1990's. The middle reaches of the Huang He are the main source of floodwater and silt in the Huang He. Development of this section of the river could provide peak regulation power sources for the North China Grid and create the conditions for supplying water to the thermal power base area and diversion of the Huang He for irrigation. It also could block silt, reduce its accumulation in the downstream river channel, and reduce the danger of flooding in the lower reaches. We should build Wanjiazhai and Xiaolangdi during the Eighth 5-Year Plan and plan on building Longkou, Qikou (or Yumenkou), and other hydropower stations during the Ninth 5-Year Plan. The scale of new construction starts over 10 years would be about 6,000MW.

6. In regions with coal and power shortages and rather good hydropower development conditions, we should focus on building several medium-sized hydropower stations

1) Accelerate construction of several medium-sized power stations with rather good regulation properties and rather small inundation, increase the peak regulation capacity, and increase the capacity for supplying power during dry periods. We should start new construction at Songjianghe, Muyangxi, and Mianhuatan hydropower stations and Zipingpu and Baise key water conservancy projects, and so on, with an installed generating capacity of about 3,000MW.

2) Take full advantage of the regulation and storage role of reservoirs that have already been built or are now under construction, develop several matching downstream hydropower stations that have low heads, small inundation, and reverse regulation properties like Gaobazhou, Lingjintan, Zilanba, Wangpuzhou, Xunyang, Xihe, Jinkeng Gaoling, Taihe, Qilinsi, and so on. The 10-year plan for new construction starts should have a scale of about 2,000MW.

3) Build several medium-sized hydropower stations with large power output and rather short construction schedules in regions with coal and electric power shortages such as Taipingyi, Dongxiguan, Wasigou, Shibanshui, Hongjiang, Wanmipo, Xiaoxia, Geliqiao, and so on. The scale of new construction starts over 10 years would be about 1,300MW.

7. Build several pumped-storage power stations in regions with a large proportion of thermal power, weak grid peak regulation capabilities, and relatively limited hydropower resources

To regulate peaks and fill in valleys and ensure safe and economical operation in the East China, North China, Northeast China, Guangdong, and other power grids, we should build pumped-storage power stations. Besides the Guangzhou first phase and Shisanling pumped-storage power stations, we should start construction of Tianhuangping, Pushihe, Zhanghewan, and Guangzhou second phase pumped-storage power stations during the Eighth 5-Year Plan and start new construction at Xilongchi, Heilongjiang Province pumped-storage, Xiangshuijian, Taian, and other pumped-storage power stations during the Ninth 5-Year Plan. The scale of new construction starts over 10 years would be about 8,000MW.

8. Actively support development of the medium and small-scale hydropower industry, supply power to rural areas, promote local economic development

China has a huge population and vast territory, uneven economic development, and power shortages over a vast rural area and in townships and towns. China has very abundant developable medium and small-scale hydropower resources (almost 100,000MW) that are very widely distributed. Thus, active support for medium and small-scale hydropower construction is an important way to provide power to rural areas and develop local economies. We should build 8,500MW in medium and small-scale hydropower larger than 100MW over 10 years, mainly in Sichuan, Fujian, Hunan, Hubei, Guangxi, Zhejiang, Yunnan, Guizhou, Xinjiang, and other regions.

#### IV. Policies and Measures

We propose adoption of the following measures in order to achieve the development goals of the 10-year hydropower construction plan:

A. Increase investments in hydropower, increase the ratio of hydropower resources

Compared to thermal power without including coal mine and railroad construction, hydropower requires longer construction schedules and more project investments and interest. Because hydropower includes investments in comprehensive utilization projects and power transmission and transformation, hydropower requires larger investments than the equivalent capacity of thermal power, so it will be impossible to maintain 30 percent of installed generating capacity if hydropower accounts for 18 percent of investments in electric power as it does now. To solve this problem, we must increase investments in hydropower and establish stable sources of investment capital. For this purpose, we propose: 1) The state should use over 50 percent of its administrative capital for electric power capital construction each year to build large and medium-sized hydropower stations. 2) The state should centralize an additional 0.02 yuan per kWh requisitioned from hydropower as an electric power construction fund and use it to build large hydropower stations. This is especially true for multi-province projects with strategic significance, where it is best for the state to arrange the investments. 3) Seek

low-interest loans between international financial organizations and the government for building large hydropower stations, with the state unifying borrowing and repayment.

B. The state should implement primary energy resource policies for hydropower that are equivalent to those for extracting petroleum and coal

The state should provide hydropower with equivalent preferential conditions and equivalent primary energy resource policies like those for the extraction of petroleum and coal and stipulate lower loan interest rates and longer loan repayment schedules, such as the World Bank's interest rate of 3 to 8 percent for loans to hydropower projects and loan repayment periods of 25 to 30 years.

C. Rationally readjust peak and valley electricity prices, implement prices for power supplied to grids that are equivalent to those for thermal power

Peak and valley electricity prices should be readjusted to increase the differential. Hydropower also should implement new prices for new power and prices for electricity supplied to grids that are equivalent to those for thermal power. On this basis, calculate the power generation benefits of hydropower and use them as a source of increased investments in hydropower construction.

D. Further reduce reservoir inundation losses, truly and rationally solve the problems of inundation compensation and population resettlement arrangements

Beginning in the 1960's, selection of construction projects in planning and design programs could conscientiously study the question of reducing hydropower station reservoir inundation losses. Statistics show that the average amount of cultivated land inundated per kW was 0.34 mu in the 1950's and 0.13 mu in the 1960's, and was reduced to 0.09 mu in the 1970's and 0.04 mu in the 1980's. It is only 0.023 mu for the 10-year plan covering the Eighth 5-Year Plan and Ninth 5-Year Plan, which is 7 percent the figure for the 1950's. The number of people resettled per kW was reduced from 0.29 people in the 1950's and 0.09 people in the 1960's to 0.06 people in the 1970's and 0.036 people in the 1980's. It is 0.023 people in the 10-year plan, just 8 percent of the number during the 1950's. However, the cost of compensation for reservoir inundation at present continues to rise and population resettlement is becoming increasingly difficult. We feel that, on the one hand, more consideration should be given to rational utilization of hydropower resources and the need to reduce inundation losses in future planning, design, and site selection work, and that on the other hand, the state should accelerate legislation and reinforce coordination, and local areas should support good plans for population resettlement arrangements, use population resettlement funds well, and provide good production and living arrangements for the people who are resettled. We propose that reservoirs be given the same deductions for depreciation and major overhaul expenses as large dams and that they be used to

subsidize restoration and support of the production and livelihood of the resettled population. Or, a reservoir development fund can be requisitioned from the power generated by hydropower to make arrangements for the resettled population over a specific period of time and reduce capital construction investments during the construction period.

E. Implement rational sharing of project benefits and the costs of investments, exempt hydropower from land occupation taxes

For a long time, the relevant departments have only set requirements and collected benefits from hydropower, which involves comprehensive utilization projects, without assuming responsibility for investments and expenditures and without assuming economic responsibility. This has increased the burdens on hydropower. Thus, all hydropower projects with comprehensive utilization benefits should implement rational sharing of benefits, investments, and costs, with hydropower assuming responsibility for the share of investments and operating costs in special power generation projects and public projects. The state should provide investments and operating costs for flood prevention, irrigation, and water-borne transportation, which fall under social and public activities and have substantial social benefits.

Development of hydropower and building reservoirs to store water requires flooding land and resettling populations. However, it can also raise downstream flood prevention standards, reduce the danger of flooding and waterlogging, and protect industrial and agricultural production. Some can also develop and utilize additional cultivated land and provide substantial benefits for society and the people. Thus, we propose that the state exempt hydropower from land occupation taxes.

F. Begin with our national conditions, determine construction standards, optimize designs, reduce power plant construction costs, shorten construction schedules

A main cause of the current increase in hydropower investments is that the relevant departments have issued very high construction standards and requirements when hydropower stations are being built. Thus, higher levels should formulate design standards adapted to China's economic conditions. Higher authorities or comprehensive departments should also reinforce coordination to deal with several excessively-high requirements.

We must start with reality, do survey research, adopt advanced design standards, apply advanced technologies, optimize plans and designs, reduce the amount of engineering, and conserve investments. We also should summarize and extend successful experiences in hydropower construction, strive to shorten construction schedules, and reduce construction costs.

G. In regions with abundant hydropower resources and a large proportion of hydropower, arrange seasonal power-using enterprises

Southwest, south-central, and other parts of China have abundant hydropower resources and a rather large proportion of hydropower, and they have quite a bit of seasonal power use. We can integrate with local resource conditions and develop the energy-consuming metallurgical industry to an appropriate extent, arrange large seasonal power users, and use this renewable resource, hydropower, to conserve coal and other consumable energy resources. This can also promote accelerated development of hydropower.

**H. Accelerate development of low-head large capacity through flow generators and pumped-storage generators**

Based on the tentative ideas in the 10-year plan, the total installed generating capacity in pumped-storage power stations now under construction or planned for new construction is 10,000MW and the installed generating capacity in new low-head medium-sized power stations to be constructed is about 1,500MW. It will be hard to develop the pumped-storage power station generators and rather large capacity through flow generators in China and imports would require substantial foreign exchange, so they would account for a very large proportion of the total investments in power stations. If we can accelerate development and use Chinese-made generators, this could reduce the costs of power station construction, conserve foreign exchange, and develop China's electromechanical manufacturing industry.

**I. Increase funds for hydropower preparatory work, accelerate hydropower preparatory work**

Preparatory work for hydropower cannot keep pace now and our design reserves are small and far from capable of meeting the needs of hydropower development. One important cause of this situation is inadequate funds for preparatory work. Given the development situation in hydropower construction, to provide and stabilize capital sources for preparatory work, we propose that the state increase hydropower resource exploration funds by an appropriate amount and allocate a portion of the newly requisitioned 0.02 yuan for hydropower preparatory work to establish a hydropower preparatory work fund and increase inputs on hydropower preparatory expenditures. For problems which concern contradictions between local areas and departments, higher-level departments and comprehensive departments should increase timely coordination of management and try to avoid putting off resolutions to problems. For medium-sized and small hydropower projects, local planning, financial, and water conservancy and electric power production departments should squeeze out a little more capital to intensify preparatory work. Otherwise, they may cause problems and waste in project construction. In summary, on the one hand we should do good medium and long-term planning for hydropower and clarify near-term construction foci as soon as possible, while on the other hand we must increase inputs in preparatory work expenditures and make major efforts

to increase design reserve projects to create the conditions for selective development and accelerate the development of hydropower.

**J. Reform the hydropower system, make it benefit acceleration of hydropower development**

The current tangle of electricity prices and unified accounting for thermal power and hydropower have obliterated hydropower's advantages. Combined with the irrational investment burden, the relevant departments have been forced to "seize and consume large projects". If we wish to accelerate hydropower development, we must implement policies and reform the system to make them more conducive to accelerating hydropower development. If the relevant policies and measures for hydropower investment, electricity prices, taxation, primary energy resources, and so on are not fulfilled and the system is not reformed, it will be meaningless to talk of accelerating hydropower development and improving the energy resource structure. Thus, we propose the establishment of hydropower river basin (regional) development companies and the implementation of policies to support them to give them real administrative authority over development and enable them to carry out independent accounting and sell electricity to grids, implement contractual responsibility for inputs and outputs, and gradually increase their capacity for using hydropower to develop hydropower. At the same time, we should fully foster the advantages of design units and implement reform policies on a trial basis like overall contractual responsibility for projects centered on design and project supervision and management centered on design units, and so on. The state should reinforce centralized unified leadership over hydropower construction, overcome policies issued by a multitude of departments, reinforce coordination, and truly resolve the problems that exist in accelerating hydropower development.

**Hydropower Station Technical Upgrading Plan  
Outlined**

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[Article by Yang Jindong [2799 6855 2767] of the Ministry of Energy Resources Electric Power Department: "An Overview of Plans for Technical Upgrading at Hydropower Stations"]

[Text] There have been substantial developments in hydropower construction in China since our nation was founded. At the end of 1989, China's total hydropower installed generating capacity was 34,580MW, with yearly power output of 118.5 billion kWh, equal to 28 percent of China's total electric power installed generating capacity of 126,600MW and 20 percent of our yearly power output of 584.7 billion kWh. We have 112 large and medium-sized hydropower stations with an installed generating capacity of 22,000MW and yearly power output of about 86 billion kWh. With continual

development of the hydropower industry, continual progress in science and technology, and expansion of the scale of hydropower, the role of hydropower in the electric power system is becoming increasingly prominent. According to incomplete statistics, hydropower accounted for 3,320MW in the Northeast China Grid, equal to 18.4 percent, for 6,930MW in the Central China Grid, equal to 41.1 percent, and 3,890MW in the Northwest China Grid, equal to 50 percent. In some provincial grids, hydropower accounts for 1,140MW or 40.7 percent in Fujian, for 1,340MW or 62.9 percent in Guangdong, for 900MW or 49.1 percent in Guizhou, and for 1,810MW or 44.5 percent in Sichuan. Hydropower also accounts for a substantial proportion in other large grids and provincial grids. Construction of these hydropower stations and their safe and economical operation have provided inexpensive motive power for sustained development of national economic construction and played an enormous role in taking on the burden of peak regulation, frequency regulation, and accident reserves in the electric power system and in grid safety, economy, and stability.

With the continual expansion in the scale of hydropower construction, the status and role of hydropower in grids is growing continually and ever-higher demands are being placed on the technical equipment in hydropower stations. Since the Sixth 5-Year Plan, to deal with the problems of low design standards in hydropower stations, poor technical equipment, leftover capital construction, and many other areas, we have undertaken exploitation of potential and technical upgrading plans focused on perfection and made definite achievements. This article will present an overview of the current situation with technical equipment at hydropower stations, achievements in transformation over the past 10 years, and plans for technical upgrading over the next 10 years.

#### I. Achievements in Technical Upgrading of Hydropower

Since the Sixth 5-Year Plan, as a special source of support for the electric power industry, the state has returned 30 percent of the depreciation funds submitted to them by electric power departments to electric power administration departments for focused arrangements of technical measures projects to bring new vigor to hydropower station technical upgrading and technical progress. By 1988, renewal and upgrading funds used for technical upgrading in hydropower stations exceeded 100 million yuan a year. They were used for reinforcement, consolidation, and transformation of large dams or hydraulic structures at 30 hydropower stations including Huanglongtan, Zhixi, Longzui, and others, which improved safety conditions at the large dams. They upgraded flood-discharge facilities, improved flood prevention standards, and guaranteed normal power generation at hydropower stations with an installed generating capacity of more than 6,000MW. Consolidation of the large dam at Zhixi reduced leakage and eliminated hidden dangers. A reinforcement and consolidation project at the large Hongmen dam lasted 4

years and cost 25 million yuan. The normal high water level was raised from 94 m to 98 m after the project was completed and it generates an additional 45 million kWh of power each year. Flood prevention standards at Huanglongtan were too low and there had been serious accidents in which water flooded the plant building. Reinforcement and consolidation restored it to the normal operating water level in 1982. Reinforcement and consolidation of the Jiangkou, Longzui, and other large dams increased their flood prevention capacity and ensured safe passage of floodwaters. Technical upgrading was also carried out at this time for 63 generators totalling 2,400MW at 30 hydropower stations, including Yunfeng, Fengman, Qingtong Gorge, Zhesi, Xijin, Gutian, and others. The focus was on replacement of water turbine rotors with seriously low air corrosion and wear efficiency. The generators' stator coils were replaced, increasing generator output, with outstanding economic benefits. Annual power output from the Yuzixi generator was less than one-half the design figure due to severe wear by silt during the initial operation period. One hour of operation required 2 hours of repairs. After upgrading, yearly operation surpassed 5,000 hours and the interval between generator overhauls was 2 to 3 years. Capacities were increased in conjunction with upgrades of generators at several hydropower stations. Output increased by 22 percent at the No 1 and No 3 generators at Fengman. The large flow rate region efficiency was increased by 8 percent after refitting the No 4 water turbine at Xiamaling and output rose from 57.5MW to 63MW. Output increased from 75MW to 90MW after upgrading of the No 2 generator at Zhixi. Output from the No 1 generator increased 15 to 20 percent after upgrading at Xin'anling. Upgrading of four 15MW generators at Shangyoujiang hydropower station in Jiangxi increased station output from 60MW to 78MW, equivalent to adding another generator and generating an additional 11.5 million yuan of power each year. Tailwater river channel clearing projects were also carried out at Fengman, Wujiangdu, Fengtan, and other hydropower stations. This lowered the tailwater level and increased power generation benefits. Rather good safety and economic results were attained in trial work for an automatic water condition monitoring and reporting system at Baishan, Fengman, Huanglongtan, Tianqiao, and other hydropower stations. Computer monitoring and control systems adopted at Fuchunjiang, Gezhouba, Yongdinghe, Maotiaohe, and other hydropower stations raised automation levels at hydropower stations. Several hydropower stations also carried out technical upgrading targeted at generator speed regulation systems, excitation systems, and thrust axis disintegration, with very good results.

Ten years of technical upgrading have eliminated major defects and hidden dangers in the area of large dams and electromechanical equipment at several hydropower stations. This improved operating levels of technical equipment, with obvious technical economics benefits and laid an excellent foundation for future technical upgrading.

## II. The Current Situation in Hydropower Technical Equipment

Since the 1980's, although the state has spent a great deal of money on reinforcement, consolidation, and upgrading at hydropower stations that have already been built, with rather good results, because of historical factors, there are still extremely serious safety and economics problems with hydropower technical equipment and technical upgrading tasks are still very difficult.

China now has 112 large and medium-sized hydropower stations with an installed generating capacity of 22,000MW. Most were built prior to the 1970's. As their period of operation has grown longer, phenomena like aging of large dams and other hydraulic structures are becoming increasingly serious. Initial design standards were too low and there are quite a few residual construction defects. Added to the poor management or lack of timely maintenance and repair over a rather long period, hidden dangers are gradually being revealed in hydraulic structures, especially large dams. Some already threaten the safety and lifespan of hydropower stations. It was discovered in a national survey of 108 large hydropower station dams by the Ministry of Energy Resources Large Dam Safety Inspection Center that base pit slippage stability safety coefficients are too low at 7 plants, equal to 6 percent. There are defects in flood discharge structures and serious washouts downstream at 34 sites, equal to 31 percent. There are leaks in dam bases and abutments and overly-high pumping pressures at 54 sites, equal to 50 percent. There are serious fractures and leaks in dam bodies at 63 sites, equal to 58 percent. Flood prevention capabilities are too low at 16 sites, equal to 15 percent. There are landslips on banks near dams at 18 sites, equal to 17 percent. Moreover, earthquake resistance properties are inadequate at some large dams and incomplete large dam monitoring projects, outdated monitoring facilities or damage and loss of effectiveness are common. All these threaten the safety of large dams to varying degrees.

Preliminary statistics indicate that there are 272 generators totalling 7,480MW among China's large and medium-sized generators that have been in operation for more than 20 years. Equipment aging, declining parameters and performance, and rising breakdown rates have appeared to varying extents. These affect safety, stability, and full output at hydropower generators. In the area of water turbines, air corrosion and wear are serious, especially in generators on rivers with large amounts of silt. Performance is dropping, losses are serious, the interval between major overhauls has shrunken, and repair costs have risen. Second, product technologies for generators from prior to the 1960's are poor and parameters are low. Added to degraded operating conditions, excessive use, and serious equipment aging, several generators have troublesome defects that have existed since they became operational such as cracking of the bases of rotor blades, blade blocking and resistance, and so on which are direct threats to safe generator operation. They are manifested in the area of

generators as old and aging stator coil insulation that breaks down and causes accidents, irrational ventilation and cooling systems, impeded air routes, and substantial wear, poor quality materials in brake rings and the appearance of cracking during operation, and initial operating temperatures in hydropower station generator thrust axles that are too high and burning that causes generator shutdowns or restricted output operation.

Moreover, problems like instability of speed regulators and excitation systems, inflexible operation, low basic automation levels, and so on make it impossible to meet the need for safe and stable grid operation.

There are also several hydropower stations throughout China at which construction debris from capital construction, failure to completely remove downstream weirs, and other factors have led to rising tailwater levels, affecting power station output. These are also important topics that urgently require solution.

## III. Foci and Goals in Hydropower Technical Upgrading

Beginning in the Eighth 5-Year Plan, technical upgrading at hydropower stations gradually shifted toward technical progress focused on equipment perfection. Besides continuing to focus on reinforcement, consolidation, and upgrading to eliminate hidden dangers, we must try to adopt advanced, mature, and practical new technologies, new equipment, and new materials to enable large hydropower station dams and power generation equipment to maintain very good levels, increase reliability and availability rates, further exploit potential, increase benefits and efficiency, and raise hydropower station technical equipment to a new level.

First, formulate plans focused on arrangements to deal with reinforcement and consolidation of large dams at 22 hydropower stations with rather substantial problems that affect safety, including Fengman, Qingtong Gorge, Huilongshan, Tianqiao, and others and make obvious improvements in their safety conditions. Formulate plans for defect-free and dangerous dams at hydropower stations that go into operation during 1990. Make existing large dams attain standards in current state stipulations and "normal dam" levels, avoid accidents at large dams, prevent dam collapse accidents due to man-made causes.

At the same time, require reliability indices for all 40MW hydropower generators to attain the indices required by the Ministry of Energy Resources, replace several old generators that have reached the end of their lifespan and cannot be perfected in a planned manner, deal quickly with major hidden dangers and quality problems left over from capital construction or revealed during operation that seriously threaten normal production, actively promote expansion of generators and increased capacity based on possible conditions and objective requirements, fully exploit equipment potential, and increase the comprehensive utilization benefits

of hydropower stations. During the 1990's, the focus of technical upgrading in hydropower stations should include these areas:

**A. Eliminating hidden dangers at large dams**

An important task in technical upgrading of hydropower stations is to reinforce and consolidate existing large dams with defects and ensure hydropower station safety and the safety of the lives and property of people downstream from reservoir regions. Use technical upgrading to arrange projects for reinforcement and consolidation of dams with defects each year. The focus now should be on urgent consolidation to deal with 22 large dams that have many problems and relatively serious defects to enable these large dams to attain normal dam levels via reinforcement and upgrading, ensure safe operation of these large dams, and prevent accidents at large dams.

**B. Upgrade old equipment, carry out technical renewal, increase equipment reliability and economy**

We have installed a total of 372 generators larger than 10MW with a total capacity of 20,100MW at large and medium-sized hydropower stations since the nation was founded, and 272 of them with a capacity of 7,480MW, equal to about 38 percent, have been in use for more than 20 years. Because of technical restrictions at the time, these generators have poor equipment properties and low efficiency. Several generators have degraded and aged because of silt wear and other natural conditions, and the equipment wear situation is serious. We should upgrade these generators in a planned and focused manner to increase the efficiency of these generators by 1 to 2 percent after upgrading and increase their output by an average of 15 to 20 percent.

**C. Undertake optimized dispatching at reservoirs, increase hydropower benefits**

Increasing the precision of reservoir water conditions forecasts, implementing optimized dispatching, rationally controlling reservoir water levels, increasing head benefits, and fully utilizing reservoir capacity can increase power output by an average of 2 to 3 percent each year. All large and medium-sized hydropower stations and cascade hydropower stations should formulate optimized dispatching programs and numerical models for reservoirs and reservoir groups, undertake research on reliability theory in hydropower operation dispatching, undertake hydropower station forecasting dispatching, and increase the precision of medium and short-term forecasts. We gradually adopt trial points for implementation first at hydropower station reservoirs with obvious economic benefits and strive to achieve optimized dispatching at reservoirs at most existing hydropower stations and newly-constructed hydropower stations by the year 2000.

**D. Increase automation levels at hydropower stations, used focused extension and application of computers to carry out safety monitoring and economic operation**

Most of China's large and medium-sized hydropower stations have definite levels in the area of automation at present and automatic control of generator startup and shutdown and automatic control of power generation can be carried out locally or from a remote site, but reliability and automated technology levels are low. The main problems are poor quality and performance of automatic devices and components, design conditions and working environments that cannot satisfy requirements, a lack of reserve products and matching components, and so on.

**1. Perfect and upgrade basic automation devices and components.** Most of the problems at present concern water turbine speed regulators, generator excitation devices, and water turbine automation components. The focus should be on upgrading and replacement. Automation devices should attain breakdown-free intervals of more than 10,000 hours after upgrading and automation components should enable a generator startup and shutdown success rate of more than 99.5 percent.

**2. Use computers to achieve economical load matching between generators and develop economical operation.** Make water turbine flow rate and efficiency measurements at large hydropower stations, cascade hydropower stations, and large runoff-type hydropower stations to make them set up combinations according to optimum efficiency and attain most economical output operation for entire stations or entire cascades to increase the economic benefits of entire stations or entire cascades.

**3. Apply electronic computers in a focused way in large hydropower stations to achieve real-time monitoring and control and achieve automatic control and economical load matching in cascade hydropower stations.** The benefits are raising safe and economical operation levels and achieving full-process dynamic economic and safety monitoring and control, reducing the time required to deal with accidents, and reducing operating personnel. We must strive to complete all the tasks arranged for 12 hydropower stations during the Seventh 5-Year Plan during the Eighth 5-Year Plan. We plan to adopt computer monitoring and control of all 14 hydropower stations now under construction and large hydropower stations that will be built in the future.

**E. Large and important reservoirs should gradually achieve automatic water condition reporting**

Work in this area should be carried out in conjunction with river basin information transmission systems. We should begin with actual conditions, base ourselves on domestic supplies, carry out trials first, and then gradually extend them. Based on plan requirements, we should strive to implement them in reservoirs at 30 hydropower stations prior to the year 2000 and thereby quickly and accurately provide water conditions information to ensure flood prevention and floodwater discharge safety and foster economic benefits.

**F. Replacement and upgrading focused on monitoring systems for large dams at hydropower stations**

Establishing perfect applied large dam safety monitoring and control systems, applying electronic computers for analysis and processing of the monitoring results for large dams, and providing timely and accurate working conditions for large dams are essential conditions for safe operation of large dams. Safety monitoring systems at most large dams at hydropower stations now are imperfect, monitoring projects are incomplete, monitoring facilities and measures are backward, equipment is outdated and damaged, and so on. We should arrange to gradually replace and upgrade them in a focused manner prior to the year 2000.

#### G. Focus on tailwater silt removal work

To deal with the problem of the raising of water levels by the accumulation of debris in the tailwater and reductions of power output at some power stations among those hydropower stations that have already been completed, we should begin doing survey research prior to 2000, formulate silt clearing and debris dredging programs, arrange for their implementation in stages and groups, and further exploit power station potential.

#### H. Old plants should expand generators to increase capacity and raise peak regulation capabilities

About two-thirds of the 112 large and medium-sized hydropower stations already built were completed and placed into operation before the 1960's. During the early period of construction, the scale of installed generating capacity was usually rather small, so there is potential that can be exploited. Use comprehensive technical upgrading, generator expansion, or combined upgrading and increased capacity to further increase the peak regulation capacity of hydropower in the electric power system and alleviate the situation of inadequate peak regulation capacity in the electric power system. At the same time, we can also select hydropower stations with excellent conditions for upgrading into pumped-storage power stations. All of these should be included in technical upgrading plans in all grids after comprehensive technical economics debates and feasibility analysis for planned implementation. As an initial plan, we should select hydropower stations with good conditions for generator expansion or upgrading to increase capacity prior to the year 2000. Projections indicate that capacity can be increased by more than 1,000MW.

#### IV. Some Views on Reinforcing Management of Technical Upgrading for Hydropower

Hydropower station technical upgrading involves relatively difficult systems engineering and requires unified plans that take all aspects into consideration. We should begin with survey research, target problems in hydropower equipment (including facilities) with major hidden dangers that urgently require solution, arrange gradual implementation in a planned manner, emphasize technical rationality and economic feasibility, take into consideration the possibility of upgrading, achieve solid plan implementation, be concerned with real

results, and truly foster investment benefits. Hydropower technical upgrading requires the formulation of effective measures.

1. Do good, solid technical upgrading plans, arrange good annual plans. First, we must gain a comprehensive understanding of equipment conditions, carry out the necessary scientific debate and technical examination and acceptance for upgrading projects, avoid all attempts to start projects blindly, use feasibility research to make final decisions on project content, and arrange for their implementation over a period of years according to capital raising conditions.

2. Reinforce preparatory work for technical upgrading, select optimum upgrading programs. The quality of preparatory work for technical upgrading directly concerns the success or failure to upgrading projects. We must adhere to a scientific working style and an attitude of seeking truth from facts. Major projects must submit feasibility research reports and be implemented only after inspection and approval by administrative departments. Departments which administer the projects should arrange for specific preparatory work funds and promote the carrying out of upgrading work.

3. Actively raise capital. The main source of capital for technical upgrading is basic depreciation at hydropower stations. This capital is controlled by administrative departments at the present time. This requires unified arrangements with consideration for all areas and rational arrangements. Preferential arrangements should be made for dealing with hidden dangers at large dams and major equipment defects.

4. Manage technical upgrading projects well. First, we must do good design, construction, and benefit analysis work for technical upgrading projects and establish grades for technical upgrading projects. The benefits and costs of each upgrading project must be analyzed, and stronger management, superior project quality, and improvements in project safety conditions should be commended and supported. Responsibility for projects that are begun blindly, poor management, no apparent economic benefits, and waste should be sought in administrative departments.

Our total installed hydropower generating capacity will grow to 80,000MW by the end of this century. With continual expansion in the scale of hydropower production, the tasks of technical upgrading will become increasingly arduous and all personnel involved in hydropower production, management, and operation should fully understand the responsibilities they bear, do their work solidly and well, and make greater contributions to the cause of hydropower production and construction.

### Level of Hydropower Equipment Development Evaluated

916B0036A *Shanghai DONGLI GONGCHENG [POWER ENGINEERING]* in Chinese Vol 10, No 6, 25 Dec 90 pp 11-15

[Article by Peng Zeyuan [1756 3419 0337] of the Chongqing Water Turbine Plant: "Hydropower Equipment Development Levels in China and Foreign Countries"]

[Excerpts] [passage omitted]

### IV. Hydropower Equipment Development Levels in China

#### A. An overview of hydropower equipment development in China

China's hydropower equipment manufacturing industry developed quickly only after liberation. Before liberation, we merely relied on imports of hydropower equipment. Our first 800 kW mixed flow generator was manufactured at Harbin Electric Machinery Plant (formerly called the Shenyang No 5 Electrical Engineering Plant) in 1951. In 1958, this plant also successfully developed our first 1.6MW vertical axis rotating blade water-turbine generator. Chongqing Water Turbine Plant also developed our first 250 kW S-type axially-extending through flow water turbine in 1958. This plant also developed the horizontal axis impulse generator with the highest head in China in 1966. It had a head of 614 m and a single unit output of 600 kW. The Harbin Electric Machinery plant manufactured China's first 8MW inclined flow generator in 1970 and developed a 300MW mixed flow generator, the largest in capacity in China at that time, during the same year. Chongqing Water Turbine Plant developed a mixed flow generator in 1970 with the highest head in China, 305 m. Chongqing Water Turbine Plant also developed our first 1.6MW bulb-type through flow generator in 1971. Tianjin Power Generation Equipment Plant successfully developed an 11MW dual-speed reversible inclined flow generator in 1972. Dongfang Electric Machinery Plant successfully developed an axial flow rotating blade generator with the largest rotor diameter (11.3 m) in the world and the largest single unit capacity in China (170MW) in 1979. Jinhua Water Turbine Plant developed our first 500kW bulb-type tidal generator in 1980. Tianjin Power Generation Equipment Plant developed a 10MW bulb-type generator, the largest single unit capacity in China, in 1981. Dongfang Electric Machinery Plant developed a 320MW mixed flow generator, the largest in single unit capacity in China, in 1984. Harbin Electric Machinery Plant also developed our first 50MW vertical axis fixed-blade generator in 1984. Chongqing Water Turbine Plant developed a 15MW impulse generator (with a rotor diameter of 2.15 m, the largest impulse rotor in China at present), the largest in single unit capacity in China, in 1986. Chongqing Water Turbine Plant developed our first vertical axis four-nozzle impulse generator in 1990, and it is now manufacturing 15MW bulb-type through flow generators (rotor diameter 5.5

m), the largest in single unit capacity in China, and the highest head (1,022.4 m) impulse generator in China. The former has been installed at Anju hydropower station in Tongliang County, Sichuan Province and is expected to begin operation in 1991. The latter has been installed at Tianhu hydropower station at Quanzhou in Guangxi, and is expected to begin operating in 1992.

#### B. The water-turbine generator with the largest single unit capacity in China

The largest capacity water-turbine generator now being manufactured in China is the 355.6 MVA water-cooled generator manufactured by Harbin Electric Machinery Plant. The generator's largest iron core outer diameter is 17.6 m, the highest voltage is 18 kV, and the maximum thrust load is 3,800 t.

[passage omitted]

### V. Conclusions

The above makes it easy to see that China still lags considerably behind world levels. China's mixed flow generators and axial flow generators have now approached advanced world levels, and our through flow generators are now developing toward higher capacity. However, China's impulse, inclined flow, inclined impulse, and pumped-storage generators still lag substantially behind advanced international levels. China still has no full through flow water-turbine generators, and axially-extending through flow units are still not in wide use in China. China's is the world's richest nation in hydraulic resources. We have total reserves of 680,000MW and a developable capacity of 378,000MW that could generate 190 million kWh of power annually [as published], but we have developed and utilized just 6 percent of it so far. Achieving the goal of an installed generating capacity of 80,000MW by the year 2000 will require much greater effort by China's hydropower engineering employees and hydropower equipment manufacturing plants. [passage omitted]

### Speeding up Hydro Development in Coal-Short Regions

916B0030B *Beijing SHUILI FADIAN [WATER POWER]* in Chinese No 12, 12 Dec 90 pp 19-22

[Article by Zhang Quan [1728 0356], chief economist in the State Energy Resource Investment Company: "Accelerate Development of Medium-Scale Hydropower in Coal-Short Regions—The Current Situation, Development Principles, and Issues in China's Medium-Scale Hydropower"]

[Text] China holds first place in the world in hydropower resource reserves and is also very rich in medium-scale hydropower resources. The results of the 1980 National Hydropower Resource Survey indicate that China has a medium-scale hydropower resource installed generating capacity of 65,920MW which generates 318.1 billion kWh of power annually. All regions have also proposed

river plan achievements over the past 10 years. According to the most recent statistics from the Hydropower Technical Economics Consulting Department in the China Hydroelectric Power Engineering Society, China's total medium-scale hydropower resource installed generating capacity is 74,840MW and yearly power output is 347.7 billion kWh, up by 13.5 percent and 9.3 percent, respectively, over the 1980 survey achievements.

China has been rather concerned with developing medium-scale hydropower since the nation was founded. During the First 5-Year Plan, we began developing Longxi He in Sichuan, Shangyou Jiang in Guangxi, Gutian Xi in Fujian, Liuxi He in Guangdong, Liulang-dong in Yunnan, and other medium-scale hydropower projects and all were treated as a focus in state electric power construction at that time. China's medium-scale hydropower has attained a definite scale over 40 years of construction: China has built a total of more than 100 medium-sized hydropower stations. By the end of 1989, the installed generating capacity had reached 7,020MW, with yearly power output of 23.35 billion kWh.

The completion and operationalization of large numbers of medium-sized hydropower stations has played a definite role in alleviating power shortages in several regions, reducing pressures on coal and transportation, and promoting economic development. From the 1950's to 1970's, medium-sized hydropower stations played important roles in grids in Yunnan, Guangxi, Guangdong, Fujian, and other provinces and autonomous regions. The 1988 annual statistical report on the energy resource industry indicated that in the electric power systems of the 12 southern provinces and (autonomous regions) of Zhejiang, Fujian, Anhui, Jiangxi, Hubei, Hunan, Guangdong, Guangxi, Hainan, Sichuan, Guizhou, and Yunnan, the medium-sized hydropower installed generating capacity was 5,117MW and yearly power output was 20 billion kWh, equal to 13.4 percent of the total capacity in these electric power systems and 11.4 percent of their total power output. This is equivalent to conserving 12 million tons of raw coal, 20.6 percent of the amount of raw coal shipped into these provinces (autonomous regions) during 1988, so the benefits are obvious.

To promote accelerated development of China's medium-sized hydropower, I offer these views and opinions:

**A. Development of medium-scale hydropower is still very poorly adapted to the needs of national economic development**

Although China's medium-scale hydropower has developed a great deal, it is still very poorly adapted to objective conditions and needs.

1. The current situation in the development of China's hydropower is very poorly matched with our available hydropower resources

China's total hydropower installed generating capacity reached 34,580MW in 1989. This included 14,740MW in large scale, equal to 42.6 percent, 12,820MW in small scale, equal to 37.1 percent, and 7,020MW in medium scale, just 20.3 percent. This situation of two large ends and a small middle is very poorly matched with China's situation of a huge population and vast territory, abundant medium-scale hydropower resources, and unevenly developed economy. The problem is even more acute in some provinces (autonomous regions). Hunan Province, for example, has 9,340MW of developable hydropower resources with an installed generating capacity larger than 10MW, of which 45.8 percent is large scale and 45.1 percent is medium scale. Small scale larger than 10MW accounts for 8.9 percent. Calculated on the basis of the scale of hydropower construction already built and now under construction, 60 percent of the large scale has been developed and utilized and 41.4 percent of the small scale has been developed and utilized, but only 14.2 percent of the medium scale has been developed and utilized. Hunan has had a power shortage for a long time and it has insufficient coal and rather difficult transportation conditions. However, much medium scale hydropower which has the advantages of being "short, easy, and quick" has not been utilized. This is very irrational.

**2. The current situation in medium-scale hydropower development is very poorly adapted to the need to readjust the energy resource structure**

Looking at energy resources, China has abundant coal resources, and they are the main pillar of our energy resource production structure. Coal production has grown very quickly over the past several years, but because of inadequate investments, the scale of construction starts during the Seventh 5-Year Plan was reduced by more than one-third over plans, and as a result the scale of construction starts shifted to the Eighth 5-Year Plan will be reduced by one-third from plans. There will be a shortage of more than 40 million tons in the construction scale compared to that carried over from the Sixth 5-Year Plan to the Seventh 5-Year Plan. The effects of this reduced scale of construction will be inadequate reserve strengths, which will present substantial problems for future coal production. Second, because China's coal resources are unevenly distributed, a situation in which "coal is transported from north to south China" and "coal is shipped from west to east China" has taken shape. The volume of coal hauled on railways during 1989 accounted for 41 percent of the total annual freight volume, up 7.8 percent over 1988. This has already surpassed the 4.4 percent rate of growth in railway freight volume over the same period. As a result, both coal production capacity and transport capacity will restrict the rate of thermal power construction in the future. In this type of situation, readjustment of the energy resource structure, taking full advantage of China's abundant hydropower resources, and accelerated hydropower construction, especially acceleration of medium-scale hydropower construction in coal-short

regions of south China, have become strategic measures for energy resource development at the present time.

3. The current situation in medium-scale hydropower development is very poorly adapted to the requirements of social power use

China's energy resource industry at present is a weak link in our national economy. Insufficient electric power is still a major factor that restricts economic development. This is especially true following intensive reform of the economic system. Local enterprises (including township and town enterprises) have developed quickly and they now account for a significant proportion of the national value of industrial output, profit and tax income, and foreign exchange earnings in China. In general, there are substantial power shortages in large grids in the coal-short regions of south China, and development of many local enterprises, especially township and town enterprises, depends on small-scale hydropower. As the economy has grown over the past several years, small-scale hydropower has been unable to meet demand, and there is an urgent need to develop medium-scale hydropower. For example, Youxi County in Fujian Province, a trial electrification county which has already attained the standard, had a small-scale hydropower installed generating capacity of 41.27MW in 1989 that generated 145 million kWh of power, but it is no longer capable of meeting the needs of economic development. For this reason, approval of a start on construction of Shuidong hydropower station with an installed generating capacity of 60MW was approved in 1990. Guangxi's Wuzhou Prefecture had an installed medium and small-scale generating capacity of 218MW in 1989 that generated 800 million kWh of power annually. It can no longer meet the needs of regional economic development, so it also began building Zhaoping hydropower station with an installed generating capacity of 63MW in 1990.

4. Compared to the development of medium-scale hydropower in foreign countries, China has great potential for medium-scale hydropower and substantial development prospects

China so far has developed and utilized just 9.1 percent of its medium-scale hydropower resources, and medium-scale hydropower accounts for just 20 percent of the hydropower that has been developed, so we are very low both in the proportion of the total it accounts for and in the extent of development.

The United States has 186,000MW of developable hydropower resources which could generate 701.5 billion kWh of power annually. Statistics indicate that the installed hydropower generating capacity in the United States during 1971 was 53,400MW, including 22,100MW or 41 percent in hydropower stations with an installed generating capacity of 25 to 250MW. This is far higher than medium-scale hydropower in China, both in proportion and in absolute capacity. The United States has developed about 40 percent of its hydropower.

Problems like ever-fewer superior hydropower dam sites, inundation, population resettlement, and so on are becoming increasingly acute, so they are now working on the extent of development (transformation and expansion) and on developing medium-scale and small hydropower. Forecasts by the United States Federal Energy Management Commission concerning hydropower development during the 1990's indicate that construction permits have already been issued for construction of 410 non-federal hydropower projects with a total installed generating capacity of 91,750MW, an average installed generating capacity of 22.3MW per site, and they may be completed prior to the year 2000. There are another 345 projects awaiting permits with a total installed generating capacity of 7,800MW, an average of 22.6MW per site. In contrast, the scale of hydropower now under construction that is being developed by the federal government is only 333MW, and there is 7,400MW which has been approved for construction but building has not yet begun. This shows that non-federally developed and medium and small-scale hydropower accounts for a substantial proportion of the increase in hydropower in the United States during the 1990's. This point deserves our study.

Canada has abundant hydropower resources, with 150,000MW in developable hydropower resources that could generate 535.2 billion kWh of power annually. Its hydropower development and utilization rate reached 58 percent in 1986. Canada mainly developed large-scale hydropower, but it has given considerable attention to developing medium-scale hydropower. Statistical data indicate that Canada had 28,300MW of installed hydropower generating capacity in 1970, including 11,050MW in installed generating capacity, equal to 39 percent, at 110 hydropower stations with installed generating capacities of 25 to 250MW, which was 57 percent more than China's 7,020MW of medium-scale hydropower. There is still great potential for developing medium-scale hydropower in China.

#### B. Principles for developing medium-scale hydropower at the present time

The strategic idea of pushing forward with construction of 10,000MW in medium-scale hydropower prior to the year 2000 proposed at the National Energy Resource Work Conference held in Beijing in the spring of 1989 received warm support from all areas. The relevant departments of the state are now integrating to compile the Eighth 5-Year Plan and further implementation of the ideas for 10 years. To accelerate development of medium-scale hydropower and ensure smooth development of the cause of medium-scale hydropower, I feel that we should adhere to the following principles at present:

1. Regions with hydropower as well as shortages of coal should be the main aspect of our strategic focus

China's coal resources are mainly concentrated in the north China region, while southern provinces have limited resources, particularly in the eight provinces and one municipality along the southeast coast whose coal resources account for just 1.8 percent of our national total, whereas their industrial value of output accounts for over 70 percent. The result is that the tendency toward "shipping north China's coal to south China" is becoming increasingly prominent, which have brought on substantial difficulties. However, most of China's southern provinces (autonomous regions) have very abundant hydropower resources which fortunately form an energy resource configuration in which hydropower and coal are mutually complementary and hydropower can replace coal to a certain extent. Statistics indicate that the 10 provinces (autonomous regions) of Fujian, Zhejiang, Jiangxi, Hunan, Hubei, Guangdong, Guangxi, Hainan, Sichuan, and Yunnan have a developable hydropower installed generating capacity of 244,130MW, equal to 64.5 percent of the national total, which could generate 1,261.4 billion kWh of power annually, equal to 65.5 percent of the national total. Of this, they have a developable medium-scale hydropower installed generating capacity of 43,950MW, equal to 58.7 percent of the national total, that could generate 212.1 billion kWh of power annually, equal to 61 percent of the national total. In summary, these ten provinces (autonomous regions) account for about two-thirds of our hydropower resources and our medium-scale hydropower resources. However, the present degree of development is low and there is great potential. Among them, a substantial number of provinces (autonomous regions) must focus mainly on the medium-scale in future hydropower development because there are few large-scale hydropower resources that have not already been developed and because development is rather difficult. This type of situation opens up an avenue for developing medium-scale hydropower. All ten of these provinces (autonomous regions) are coal-short regions. Their net in-shipments of raw coal amounted to 55.37 million tons in 1989, up by 4.1 percent over the 53.19 million ton figure in 1988. Moreover, this growth trend is growing day by day, which will lead to extreme shortages of coal supplies and place great pressures on transportation. Thus, fully utilizing local hydropower resources, supplementing regional coal shortages, and alleviating electric power shortages in regions with hydropower but limited coal should be a strategic focus for national medium-scale hydropower development.

## 2. Local areas should be the main force in management systems

Developing medium-scale hydropower mainly solves the problem of local power supplies and provides direct benefits to local areas, so local areas should be the main force in preparatory work, raising and borrowing construction capital, project construction, and administration and management. At present, there are two main models in the structure of medium-scale hydropower construction investments. One is fully local investment

in construction, such as Qingxi in Guangdong, Nanjindu in Hunan, Luoxichi in Sichuan, Weituo in Chongqing, Tianhu in Guangxi, and other hydropower stations, of which there are over 10 such sites altogether in China with a construction scale of about 400MW. The second is joint investment in construction by the state and local areas, such as Xigou in Heilongjiang, Fengshuling in Zhejiang, Fancuo in Fujian, Jinggangchong in Jiangxi, Tianluo Dizhen in Hubei, Sanjiangkou in Hunan, Jinjiang in Guangdong, Zhaoping in Guangxi, Jiangkou in Sichuan, Anju in Chongqing, Lazhuang in Yunnan, Guanjiao in Guizhou, Xiaogangou in Qinghai, Dashankou in Xinjiang, and other hydropower stations, a total of 30 sites nationwide with a construction scale of 1,183MW. Excluding four sites in Xinjiang, the remaining 26 stations have a total installed generating capacity of 1,023MW and all of them were built with joint investments by central authorities, provinces (autonomous regions), and prefectures or counties (departments). The proportions of capital raised are 21.7 percent by central authorities, 16 percent through unified raising by provinces (autonomous regions), and 62.3 percent raised by prefectures or counties (departments). This means that about 60 percent of the capital sources depended on funds raised by prefectures and counties.

In summary, whether it is best for all of the investment to be raised by local areas or through joint investments by central authorities and local areas, capital raised by local areas occupies the primary status in development of medium-scale hydropower at the present time. In markets for electric power sales, although some is supplied to grids, they use most themselves. Self-management is the dominant force in administrative management. Thus, it is logical for local areas to occupy the main position in the management system. Of course, in a situation of state capital shortages, arranging a small amount of guidance capital and making joint investments with local areas to develop medium-scale hydropower is an important way to accelerate hydropower construction and provides advantages for both the state and local areas.

## 3. The scale of construction should mainly involve power stations smaller than 100MW.

The range of installed generating capacity at medium-sized hydropower stations is 25 to 250MW, which is rather substantial. There are a total of 26 medium-sized hydropower stations with installed generating capacities larger than 25MW now under construction through joint investments by the State Energy Resource Investment Company and local areas. The largest installed generating capacity is 80W and the smallest is 25MW. The average is 43.4MW per station and the unit investment per kW averages 2,393 yuan (the average investment per station is 104 million yuan). Because hydropower is a capital-intensive industry, a 50MW hydropower station, including transmission projects, costs about 150 million yuan. If 60 percent of the capital is raised by prefectures and counties themselves and they are completed in 4 years, then the prefectures and counties must provide

over 20 million yuan in funds each year, which is already very difficult for prefectures and counties in terms of their capital-raising abilities. If the scale is too large, prefecture and county finances cannot bear the burden. It is no wonder that the average scale per station for the 26 medium-sized hydropower stations now under construction is about 50MW. This construction scale per station is rather well-adapted to the capital-raising capabilities and development levels of the forces of production of most regions at the present time. In decisions on plans, site selection, and projects for medium-scale hydropower projects, we certainly must be concerned with adapting power station scales to development levels of local forces of production. At present, we usually should focus on installed generating capacities under 100MW. Of course, this does not mean abandoning selective development of several power stations larger than 100MW in areas that have the proper conditions.

#### C. The main problems that require solution at the present time

As I understand the situation, these are the main problems at present in accelerating the development of medium-scale hydropower that should be solved.

##### 1. Reinforcing preparatory work

Preparatory work for medium-scale hydropower is extremely weak. The problem is particularly acute in provinces with abundant resources like Sichuan, Hunan, and others. It is manifested concretely in: 1) A lack of design reserves for construction projects, which makes selective development difficult; 2) Insufficiently in-depth work and many design revisions after construction begins, causing budget overruns that lead to passivity in construction. To solve this problem, all areas must provide preparatory work funds. Fujian Province has been very concerned with preparatory work for medium-scale hydropower. The provincial planning commission makes unified arrangements each year and issues special assignments. The method of capital raising is also employed for the required preparatory work funds, with the province making unified arrangements for a part, electric power and water conservancy departments providing one part, prefectures and counties raising their own part, and design academies practicing strict economy and earning a part. Experiences with these four "parts" deserve consideration in all areas.

For medium-scale hydropower at the present time, besides doing good geological exploration, clarifying basic conditions, and optimizing design programs, we should also integrate with the need for intensive reform at the present time, reinforce survey research on electric power market digestion capabilities, local capital raising capabilities, construction project repayment capabilities, local abilities to bear the burden of prices for power supplied to grids, and so on in power supply regions to

enable good preparations to be made for project establishment decisions. In summary, we should focus on economic benefits, conduct comprehensive analysis, and make scientific decisions.

##### 2. Implement new prices for new power

Electric power construction is investment-intensive, and this is even more prominent for hydropower. Present electricity prices are too low and prices are distorted. This prevents many hydropower projects from having loan repayment capabilities. As a result, banks and other financial organs are not very willing to make loans to the electric power industry, especially to hydropower. This has already affected development of the electric power industry. As a result, the State Council has decided to implement new prices for new power from newly-built power plants. Some regions like Guangdong, Fujian, and others have now implemented new prices for new power. The results have been good and electric power construction has been invigorated. However, there are still many provinces (autonomous regions) which have not implemented new prices for new power, which is restricting the development of medium-scale hydropower. Experiences in all areas indicate that implementing new prices for new power and repaying principle and interest on schedule according to the relevant state stipulations is essential to provide a way out for medium-scale hydropower.

##### 3. Implement preferential policies

Reviewing construction experiences over the past 40 years, the main factor which has restricted medium-scale hydropower development is the problem of insufficient capital. To promote the development of medium-scale hydropower, we should formulate preferential policies in this area. After preliminary consideration, they might include these conditions: 1) Provinces (autonomous regions) with relatively abundant medium-scale hydropower resources should establish medium-scale hydropower development funds to guarantee stable capital sources for medium-scale hydropower construction. The method used in the Sichuan Provincial Planning Commission is to set aside and centralize part of the provincial financial budget, that portion of over-quota income shares from the energy resource fund, the requisitioned electric power fund, expenditures on using power to develop power, water conservancy expenditures, the scale of bank loans, and other channels, with the provincial planning commission making unified arrangements for using the funds to develop medium-scale hydropower. The results of this method are rather good. Hunan Province has also adopted a similar method. 2) The state sets aside some capital and employs the method of state quota investments for joint investment construction with local areas to support local areas in developing medium-scale hydropower. Hydropower is investment-intensive and requires more construction capital. Having the state invest a small amount and absorbing the scattered capital of local areas into electric power construction has practical importance for

improving the investment structure and accelerating electric power construction. Statistics from seven medium-sized hydropower projects approved by the State Planning Commission show that for a total installed generating capacity of 308MW and total investments of 630 million yuan, state quota investments were 163 million yuan, equal to 25.8 percent of the total investment. These seven medium-sized hydropower stations can be completed and go into operation during the Eighth 5-Year Plan. 3) Extend preferential policies for small-scale hydropower to medium-scale hydropower. 4) The state should exempt medium-scale hydropower from cultivated land occupation taxes. It should be treated the same as coal, with the interest on state loans to hydropower being reduced to 2.4 percent.

### Large and Medium-Sized Hydropower Stations Now Under Construction

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[Table prepared by Ma Zongyi [7456 1350 5030] of the Ministry of Energy Resources Hydropower Development Company: "List of Large and Medium-Sized Hydropower Stations Now Under Construction in China"]

[Text]

**List of Large and Medium-Sized Hydropower Stations Now Under Construction in China**

Number	Power station	Installed generating capacity (MW)	Yearly power output (million kWh)	Dam type	Year construction started	Design unit	Construction unit
1	Ertan	3,300	17,035	Dual-arch arch dam	1988	Chengdu Survey and Design Academy	
2	Lijia Gorge	2,000	5,900	Concrete arch dam	January 1988	Northwest China Survey and Design Academy	4th Hydropower Bureau
3	Shuikou	1,400	4,950	Gravity dam	March 1987	East China Survey and Design Academy	Huadian Joint Operations Company
4	Longyang Gorge	1,280	5,980	Gravity arch dam	December 1979	Northwest China Survey and Design Academy	4th Hydropower Bureau
5	Manwan	1,250	7,795	Gravity dam	May 1986	Kunming Survey and Design Academy	Gezhouba Bureau, 3d, 8th, and 14th Hydropower Bureaus
6	Yantan	1,210	5,660	Gravity dam	February 1985	Guangxi Survey and Design Academy	Guangxi Hydropower Engineering Bureau, Gezhouba Bureau
7	Wuqiangxi	1,200	5,370	Gravity dam	July 1986	South-Central China Survey and Design Academy	8th Hydropower Bureau
8	Guangzhou pumped-storage	1,200	2,380	Concrete-faced rockfill dam	1988	Guangdong Provincial Hydropower Design Academy	14th Hydropower Bureau
9	Geheyuan	1,200	3,040	Gravity arch dam	October 1986	Chang Jiang Water Conservancy Commission	Gezhouba Bureau
10	Tiansheng-qiao second cascade	880	4,920	Gravity dam	January 1982	Guiyang Survey and Design Academy	People's Armed Police 1st Hydropower Brigade
11	Ankang	800	2,860	Gravity dam	November 1976	Beijing Survey and Design Academy	3d Hydropower Bureau
12	Baozhusi	700	2,300	Concrete gravity dam	January 1985	Northwest China Survey and Design Academy	5th Hydropower Bureau
13	Baishan second phase	600	34	Gravity arch dam	September 1984	Northeast China Survey and Design Academy	1st Hydropower Bureau
14	Lubuge	600	2,821	Core wall rockfill dam	December 1983	Kunming Survey and Design Academy	14th Hydropower Bureau
15	Tongjiezi	600	3,212	Gravity dam	1985	Chengdu Survey and Design Academy	7th Hydropower Bureau

**List of Large and Medium-Sized Hydropower Stations Now Under Construction in China (Continued)**

Number	Power station	Installed generating capacity (MW)	Yearly power output (million kWh)	Dam type	Year construction started	Design unit	Construction unit
16	Dongfeng	510	2,420	Dual-arch arch dam	April 1986	Guiyang Survey and Design Academy	9th Hydropower Bureau
17	Dongjiang	500	1,320	Dual-arch arch dam	1978	South-Central China Survey and Design Academy	8th Hydropower Bureau
18	Panjiakou pumped-storage	270	630	Gate dam	1984	Tianjin Survey and Design Academy	People's Armed Policy 1st Hydropower Brigade
19	Wan'an	400	1,050	Gravity dam, core wall sand-encased dam	1978	Chang Jiang Water Conservancy Commission	People's Armed Police 2d Hydropower Brigade
20	Jinshuitan	300	490	Arch dam	1980	East China Survey and Design Academy	12th Hydropower Bureau
21	Shaxikou	300	960	Gravity dam	January 1981	East China Survey and Design Academy	Min Jiang Hydropower Engineering Bureau
22	Daguangba	240	520	Gravity dam, earthen dam	1988	South-Central China Survey and Design Academy	Gezhouba Engineering Bureau
23	Hongshi	200	440	Gravity dam	October 1988	Northeast China Survey and Design Academy	1st Hydropower Bureau
24	Taipingwan	190/20	720/200	Gravity dam	1988	Northeast China Survey and Design Academy	6th Hydropower Bureau
25	Fengman generator expansion	170	50	Gravity dam	1988	Northeast China Survey and Design Academy	6th Hydropower Bureau
26	Shuifeng generator expansion	150	86	Gravity dam	1981	Northeast China Survey and Design Academy	6th Hydropower Bureau
27	Qingxi	144	3,700	Gravity dam	1987	Guangdong Hydropower Survey and Design Academy	Guangdong 2d Hydropower Bureau
28	Dashankou	80	310	Gravity arch dam	October 1985	Xinjiang Hydropower Survey and Design Academy	People's Armed Police 5th Communications Detachment
29	Shitang	78	190	Gravity dam	July 1985	East China Survey and Design Academy	12th Hydropower Bureau
30	Puding	75	340	Rolled concrete gravity arch dam	1988	Guiyang Survey and Design Academy	8th Hydropower Bureau
31	Sanjiangkou	62.5	325	Gravity dam	September 1985	Hunan Provincial Hydropower Survey and Design Academy	8th Hydropower Bureau
32	Nanjindu	60	293	Gravity dam	September 1986	Hunan Provincial Hydropower Survey and Design Academy	5th Chinese Construction Bureau
33	Guxian	60	182	Gravity dam	July 1978	Huang He Water Conservancy Commission	11th Hydropower Bureau
34	Xiaodongjiang	55	154	Gravity dam	April 1985	South-Central China Survey and Design Academy	8th Hydropower Bureau
35	Jiangkou	51	211	Stone strip gravity dam	1987	Sichuan Provincial Hydropower Survey and Design Academy	12th Railway Bureau

## List of Large and Medium-Sized Hydropower Stations Now Under Construction in China (Continued)

Number	Power station	Installed generating capacity (MW)	Yearly power output (million kWh)	Dam type	Year construction started	Design unit	Construction unit
36	Yaotian	50	200	Gravity dam	1985	Hunan Provincial Hydropower Survey and Design Academy	Hunan Hydropower Engineering Bureau
37	Tuohai	50	284	Gravity arch dam	1984	Xinjiang Autonomous Region Hydropower Survey and Design Academy	Water Conservancy Department Hydropower Engineering Team
38	Mahui	46.1	353	Gate dam	September 1987	Sichuan Provincial Hydropower Survey and Design Academy	2d Electric Power Construction Bureau
39	Yanguo Gorge generator expansion	44	228	Broad crack gravity dam	March 1988	Northwest China Survey and Design Academy	Gansu Hydropower Inspection Company
40	Xigou	36	95	Bituminous concrete core wall dam	July 1987	Northeast China Survey and Design Academy	Hei He Xigou Engineering Office
41	Xiaogangou	32	194	Concrete-faced rockfill dam	August 1987	Qinghai Provincial Hydropower Survey and Design Academy	Qinghai Hydropower Bureau, 4th Hydropower Bureau
42	Luosichi	31.5	180	Spillway gate dam	October 1987	Sichuan Provincial Hydropower Survey and Design Academy	3d Hydropower Bureau
43	Liangqian	30	123	Gravity dam	November 1987	Fujian Hydropower Survey and Design Academy	People's Armed Police Independent Hydropower Detachment
44	Anju	30	172	Gate dam	December 1987	Chongqing Hydropower Survey and Design Academy	7th Hydropower Bureau
45	Weituo	30	156	Gate dam	November 1988	Chongqing Yongchuan Survey and Design Academy	11th Railway Bureau
46	Fengshuling	30	71	Stone faced gravity dam	September 1988	Zhejiang Provincial Hydropower Survey and Design Academy	Jinhua Wenzhou Hydropower Engineering Office
47	Wenfeng	30	166	Gate dam	1988	Mianyang Hydropower Survey and Design Academy	8th Hydropower Bureau
48	Shimiantan	28.2	112	Gravity dam	September 1986	Hunan Provincial Hydropower Survey and Design Academy	5th Chinese Construction Bureau, 8th Hydropower Bureau
49	Heizi	26	134	Clay core sand-gravel dam	October 1985	Xinjiang Autonomous Region Hydropower Survey and Design Academy	2d Xinjiang Office, Shaanxi Hydropower Engineering Bureau
50	Ganbao	25.5	184	Gate	May 1988	Chengdu Survey and Design Academy	10th Hydropower Bureau

## No 4 Unit at Xiaolongtan Now Operational

916B0036B Kunming YUNNAN RIBAO in Chinese  
28 Dec 90 p 1

[Article by Zhu Xiangwei [2612 4382 0251]: "No 4 Generator at Xiaolongtan Generates Power Ahead of

Schedule, Yunnan Provincial Government and Ministry of Energy Resources Commend Power"]

[Text] After victoriously completing 72 hours of trial operation at full load, the No 4 generator at Xiaolongtan power plant with an installed generating capacity of 100MW, a key construction project in Yunnan Province, also passed a 24 hour operating test and was formally

placed into operation to generate power on 25 Dec 90. The Yunnan Provincial Government and Ministry of Energy Resources sent a telegram of commendation to the Yunnan Provincial Electric Power Bureau.

The No 4 generator in the second phase of the Xiaolongtan power plant project was made a key construction project by the Yunnan Provincial Government and Ministry of Energy Resources that must be placed into operation during 1990. During the construction process, units doing the building encountered various difficulties like insufficient capital, late arrivals and shortages of equipment, and so on. To accelerate the pace of project construction and achieve the goal of connecting to the grid and generating power by the end of 1990, the Yunnan Provincial Electric Power Bureau provided substantial support and active coordination in manpower, finances, and materials. The Xiaolongtan Power Plant Construction Office reinforced on-site dispatching. Yunnan Thermal Power Construction Company, which was responsible for construction of the main project, reinforced construction management, boldly adopted advanced science and technology, adopted oil filters that

were relatively advanced in China for steam turbine installation, and reduced the construction schedule from installation to impulse rotation of the steam turbine by about 1 month compared to state standards.

After this generator begins operating, it will generate over 2 million kWh of power each day, which will play a positive role in alleviating the electric power shortage in Yunnan Province during the dry season and developing industrial and agricultural production in Yunnan Province.

The Yunnan Provincial Electric Power Bureau convened an on-site meeting to commemorate the success of placing the No 4 generator into operation and generating power on the afternoon of 26 Dec 90, gave commendations to 11 units which made contributions to the construction, design, and other areas, and awarded glorious titles of advanced producers to 122 builders. Representatives from the relevant departments in the Yunnan Provincial Government and relevant units in Kaiyuan City and the electric power system attended to victory meeting.

**Coal Resources in Nine Southern Provinces Surveyed**  
*916B0050A Beijing MEITAN DIXUE JISHU [COAL SCIENCE AND TECHNOLOGY] in Chinese No 1, Jan 91 pp 45-48*

[Article by Tong Youde [4547 2589 1795], Coal Industry and Technology Advisory Committee]

[Text] The nine provinces south of the Chang Jiang—Zhejiang, Fujian, Jiangxi, Hunan, Hubei, Guangdong, Guangxi, southern Anhui, and southern Jiangsu—possess coal-bearing strata from the paleolithic to the cenozoic era, among which the Ceshui group, the Liangshan, Longyan, Longtan, and Anyuan groups are fairly well developed. Well-known mining districts are Longyan, Yongan, and Tianshao Shan in Fujian; Pingxiang, Fengcheng, and Luoping in Jiangxi; Lianshao, Baisha, Zixing in Hunan; Quren, Siwangzhang in Guangdong; and Hongmao, Luocheng, and Heshan in Guangxi.

The paleo-geographic environment for coal formation in the coal bearing strata south of the Yangtze are not as good as those of the north. After the coal seams were formed, they underwent many changes in geological structure, which led to very complex conditions of coal resources. The chief examples of these are:

(1) The coal fields are incomplete and discontinuous. Coal systems in 9 provinces south of the Yangtze are widely distributed. According to incomplete statistics, there are 1572 coal producing localities overall, of which there are 503 mines in 49 mining districts (prospecting districts) with good data that have been assessed. There are 240 locations that average only about  $5 \text{ km}^2$  in area, the smallest being  $3 \text{ km}^2$ , and they make up 48 percent of the total. Areas in some provinces are even smaller, for example, 80 percent of the mines (prospecting districts) in Hubei are in locations of less than  $3 \text{ km}^2$ , 44 of which are less than  $1 \text{ km}^2$ .

(2) coal fields (prospecting districts) are broken up, compacted, folded, and have intensely inclined seams. According to statistics taken from data on mines being worked in Hunan, there are 59 locations that have an average of 196 faults per  $\text{km}^2$  with drops of more than one-half meter, the highest number being 1770 per  $\text{km}^2$ ; 44 locations where there are 45 large and small folds per  $\text{km}^2$ , the maximum being 12,843 per  $\text{km}^2$ ; and 92 locations where inclined coal seams vary from 80 to 900, with shifts between 200 to 500 at most mines.

(3) Exploitable coal seams are few, the changes in thickness of single seams being so great. According to incomplete statistics from 49 mining districts in the nine provinces, there are 285 seams that are under primary or supplementary exploitation. Of these, in the Ceshui group in northern Guangxi, central Hunan, southern Jiangxi, and northern Guangdong there are generally two layers of minable coal seams with greatly varying thicknesses that range from over 10 meters down to zero. In the Liangshan group in western Hunan, western Hubei,

and southeastern Hubei that generally have only two exploitable coal seams with an average thickness of less than 1 meter. In the Longyan group in southern and western Fujian, eastern Jiangxi, and western Zhejiang mines have clusters of as many as 10 coal seams, but the distances between the strata are small, and the seams are thin and inconsistent. The Longtan group is widely developed with many mines, and is the main exploitation area in the south. According to statistics for the typical mine there are two exploitable seams, 60 percent of which are less than 2 meters thick. About 40 percent have three or more exploitable layers with seams over 2 meters thick. In the Anyuan group in Hunan, Jiangxi, northern Fujian, and northern Guangdong there are clusters of strata with thin and inconsistent coal seams, and although there are many of them, only one or two seams are minable. The Hunan Province Coal Research Institute's statistics on 120 mines with designed capacity of over 30,000 metric tons per year show that the average mine has 2.1 exploitable strata. Among 251 strata, there are 144, or 57.4 percent, that have coal seams 1.3 meters thick or less.

(4) Coal seam formations are very complex and inconsistent. The coal seams of 285 strata under exploitation or supplementary exploitation in the nine provinces can be summed up in three categories according to their consistency: 1. Stratified formations. Approximately 10 percent of coal seams appear to be consistent or fairly consistent. 2. Bean or bead string formation. Approximately 75 percent of coal seams have large variations in thickness along the course of the seam or along its inclines. 3. Nest or lens formations. About 15 percent of coal seams have extreme variation in thickness. An analysis of 251 strata under exploitation in 120 mines shows 146 coal seams, or 58.2 percent, with points of zero thickness; 77 coal seams, or 30.7 percent have points that are unexploitable; 165 seams, or 65.7 percent, have extremes that range over and under their average thicknesses by two times, of which 53 seams varied by a factor of more than 5. These types present the nest or lens formations.

The complexity and inconsistency of coal seams in the geological structure of coal fields in the south, in the final analysis, greatly limit coal resources in the nine provinces. The average deposits in the 503 mines (prospecting districts) mentioned above on which there are considerable data, have reserves of only 1.84 million metric tons per  $\text{km}^2$ . The overwhelming majority of southern mines have soft or lean coal reserves of less than 2 million tons per  $\text{km}^2$ , indicating thin seams. Although a number of rather large-scale searches and coal field estimates have been done in the nine provinces since reconstruction, proven reserves are still very limited and make up only about 1 percent of the proven reserves in the whole country. Although there are some optimistic estimates of reserves down to 600 meters depth, they amount to only 5 percent of the total estimated reserves down to a depth of 1,000 meters for all of China. It will be difficult to make a change in the deficiency of coal reserves.

Coal is China's chief energy resource. The nine southern provinces have given priority to the development of coal resources to meet the conditions and requirements for reform, and promote development of local industry, agriculture, and transportation. Because the geological conditions of the coal seams are so poor, the utilization rate of coal reserves is necessarily very high. According to statistics from relevant departments, 56 percent of the total proven deposits are in production or under construction, among which Zhejiang, Fujian, Guangdong, and Hunan are respectively exploiting 98, 72, 66, and 65 percent of their proven deposits. That is to say, as far as geological prospecting goes (including fine and detailed final examination or final general exploration), of all of the locations that had promising coal deposit figures presented in geological reports, excluding those too far off the mark (55 geological reports that were issued between the 60s and the present, define 10 percent of the deposits in the nine provinces), the overwhelming majority are already being utilized. This demonstrates the important contribution that the coal industry makes to south China, but also, unavoidably, it causes great difficulties for the coal industry:

(1) There are large errors in deposit figures, and they are unreliable. From early on this problem had focused the attention of prospecting, design and production departments. In 1977 the coal system set up a national mining affairs bureau. The Coal Field Geology Prospecting Corporation (teams) conducted a large-scale comparison of prospecting in a variety of mines and coal fields, of which the actual deposit volumes of the inconsistent seams under exploitation in the southern provinces were compared with the geological reports, and the rate of error was as much as 26.3 to 35.2 percent. Figures for deposit volumes in many geological structures that are extremely complex, and mines with extremely inconsistent coal seams, were off by as much as 60 percent. The geology of many mines in the south, as reflected by the production departments, in contrast with the data supplied in the geological reports, were highly productive. At a number of mines the drilling conditions were such that there was no way to determine points for exploitation, the fault strata, sunken Karst columns, magma intrusions, and changes in thickness of the coal seams in the work areas caused much of the deposit volumes to bottom out to the point where efforts were discontinued.

As the conditions presented by the coal seams get more complex, the natural resource geological prospecting phase gets more difficult. According to statistics from over 400 geological prospecting reports in the nine provinces, in those prospecting areas done before 1978, an average of 9.3 drillings per  $\text{km}^2$  were made; after 1978 the average was 13.2 per  $\text{km}^2$ , or 2 to 3 times more than were done at the same time elsewhere in the country, and 4 to 6 times more than were done in Shandong. A rate of 25 per  $\text{km}^2$  was not uncommon, and the maximum were several tens to over 100 drillings per  $\text{km}^2$ . But, because of the complex geological structure and inconsistent coal seams, the actual finds were few, the fractured deposits

were difficult to pin down, and deposit figures were still not reliable. The question of how to conduct geological prospecting of natural resources in the southern coal fields, and how to set down a rationale for the extent of prospecting necessary is still a matter worthy of inquiry.

(2) Problems of mine deployment. Within the range of the coal fields there are quite large fault drops, terminations, and sudden changes in degree of incline which make coal fields that are not large in area to be excessively fragmented. This increases the points of exploitation, which increases the complexity of the transportation and ventilation systems. It requires more shafts, higher tunneling rates, lowers output per area, and causes greater losses in coal extraction.

(3) The geological factors that affect production safety are greater. Generally, as the coal seams get more complex, the problems of the close interrelationship between geological structure and the dynamics of water, gas, rock pressures, and earth temperatures increase. For example, the hydrological conditions of many Hunan, Guangxi, and Hubei mines are very complex, such as at the Hunan coal flats, and at Heshan in Guangxi where the ash and water pressures are a serious threat, and the omnipresence of high gas volumes in mines in Jiangxi, Hunan, and Guangdong, such as in Hunan where 53 percent of the mines have high methane content and eruptions of combined coal and marsh gases occur. There are also the shattered and spongy overheads, coal seams that easily catch fire, high rock pressures and earth temperatures, and many such unsafe factors.

The fact that there are such difficulties as mentioned above, with the exception of a few producing mines where conditions are quite good, as a general rule, has caused the capability to be decisive about opening up mines less than the capability to design them, and the actual output of the mines in the nine provinces to be less than had been anticipated. According to the calculations of the Hunan Coal Research Institute, for every degree of increase in complexity of the geological structure of a mine there is a decrease in utilization rate capability of 4 to 11 percent; and for every measure of increased inconsistency there is a decrease in utilization rate capability of 10 percent. Fujian Province statistics show that all small mines in the province that produce 30,000 to 60,000 tons per year have the highest utilization rates, and their actual output average exceeds designed capability by 13.6 percent. The output of the overwhelming majority of mines with a designed capability of 90,000 tons or more per year is not up to their capability, and their utilization capability rates average only about 70 percent. The results of these dissimilar calculations and statistics signify that the geological conditions of coal seams and extraction technology are directly related to coal output; the former show that the geological structure and exploitability of coal seam limit their yield, the latter show that the size and geological conditions of mines interact, and what is also revealed through the statistics is that size is not totally determined by the volume of deposits, but that geological extraction conditions of the coal seams must be taken into consideration.

China's southern coal resources, for the most part, present unfavorable conditions, and the objective reality is that there is no way to change that. Statistical data from mines subordinate to the China Consolidated Mining Corporation (table 1, 2) reveal that because coal seams of southern mines are mostly steeply inclined, thin, and have high methane gas content, they have low deposit exploitability, small size, low unit output, and high drilling rates.

**Table 1. China Consolidated Coal Corporation Minable Deposits, Output, and Partial Production Index**

Item	North	South
Average minable deposit	70.39 million tons	26.55 million
Average designed capacity	784,000 tons per year	336,000 t/yr
Average appraised capacity	871,000 tons per year	295,000 t/yr
Average annual output	900,000 tons per year	270,000 t/yr
Average monthly output	14,640 tons per face	7,075 t/f
Average rate of efficiency	6.951 tons per w/face	3.378 t/f
Production drilling rate	141 meters per 10 kt	2.51 m/kt
Start up drilling rate	17 meters per 10 kt	34 m/kt
Recovery drilling rate	120 meters per 10 kt	237 m/kt

Note: The average exploitable mine deposit in Hunan and Jiangxi is 10.5 million metric tons

**Table 2. China Consolidated Coal Corporation Mines Coal Seam Thickness, Inclination, and Methane Gas Levels**

Item	North	South
Thickness of coal seams	Percentage of deposits	
<1.3 meters	15.9	35.1
1.3 to 3.5 meters	36.6	47.2
>3.5 meters	47.5	17.7
Inclination of coal seams		
<25 degrees	89.9	56.4
25 to 45 degrees	6.1	35.5
>45 degrees	4.1	8.1
Methane gas levels		
Low methane gas level	69	23
High methane gas level	21	31
Irruptions	10	46

Note: South includes Jiangxi, Hunan, Sichuan, the Chongqing Corporation, and Guizhou

Geology is the foundation and the future of the coal industry. In recent years, under the attention and guidance of various levels of leadership, mine site surveys have been very successful, especially in the aspects of survey quality standards, technology, administration and industrial safety, have there been great achievements. After examination and acceptance, the site-survey sections of the China Consolidated Coal Corporation's bureaus and mines are already over the 80

percent mark in meeting the requirements of the standardized regulations for site surveys. In the interest of sustained production, steady and strong growth, they have made a positive contribution, and in doing site surveys in new terrains they will continue to assume even more demanding missions to lay down an excellent foundation.

Extraction is underground work, shaft conditions are poor, the labor is difficult, and the technological and administrative work is very complex. Every mine has its own geological and extraction problems. The changes in structure and coal seams affect production; water, fire, gas, coal dust, earth temperatures and pressures threaten to create disasters. At present S&T levels, some mines can be proven and ascertained, but others are very problematical, especially when geological problems are discovered or develop after extraction is underway (this is a matter of geological dynamics), and using current procedures for making precise calculations and predictions in time, space, and extent is even more difficult, but it still must be done. For this reason the scale of mine output, the level of various technological and economic indicators, the degree of safety, and even levels of mining enterprise administration, technical facilities, inspection procedures, fire-proofing capability, and expertise of personnel, all have relevance, as well as do the limitations of the objective geological conditions presented by the coal resources within the range of the coal fields.

Generally speaking, in the mines of the south, the prospecting procedures in the resource exploration phase are insufficient, and there are many unresolved questions. The physical conditions of the discontinuity of the ore seams of the coal bearing strata are more complex, and this makes the unit coal drilling rate to be high, requiring that much more extracurricular geologic recording and survey familiarization be done; mechanized processes are limited, and working conditions are demanding. The site survey department often must do a lot more work to solve one structure problem, clarify one coal seam comparative, and sometimes all that can be found is one piece of a deposit, and this, perhaps, in the large mines of the resource rich north would be inconsequential, but in the small mines of the south it would be a bonanza. For this reason it is hoped that the various levels of leadership will be willing to lend greater assistance and concern for the survey aspects as a function of the productivity of coal mines. Strengthening the mining geology effort is an important ingredient in raising the economic profitability of the coal mining industry.

At the 1988 national coal mine construction and prediction discussion conference, a deputy general manager of the Fujian Province Coal Corporation said, "Constructing mines in Fujian is basically a matter of geology, and to develop the mining industry, geological work must be done first". This also reflected the feelings of many of the leaders involved in mining activities in the south.

In recent years, in both the north and the south there has been a great deal of interest in the geological work that

precedes the actual mining tasks. Many bureaus and mines, scientific research schools and colleges, in addition to perfecting their assaying processes, also improved their basic research, and used coal field geology, structural analysis, coal petrology and coal chemistry to do comprehensive research on static and dynamic geological questions that directly affect coal production, and they enriched mining geology theory, raised the level of calculation and prediction of site and coal seam structures and other geological development conditions. According to statistics, in 1988, the site survey departments of the China Consolidated Coal Corporation's bureaus and mines put out 9,742 geological and hydrological predictions, and in the course of their development work, they had an accuracy rate average of over 90 percent, the lowest being 80 percent. Their calculations, timeliness, and accuracy earned them high praise from the production and safety departments.

In the south, the many disconformities of coal seams and lack of typical indicator-seams make correlations difficult. In the past particular emphasis was placed on research of subsurface environments to get definitive results. In recent years, experience has broadened and structure has become the key. Focus on analysis of relationships between structural formations and distribution of coal seams has had notable results in quite a few mining areas. For example, in researching folds it was found that where there is a density of folds there is widespread movement of the coal seams. On the crests and troughs of folds the seams are thicker, causing many thin and unexploitable seams to form coal pockets, making them minable, and increasing mine deposits. The structure prediction for the development of the Dingfeng Shan mine in the Fujian Longyan mining

district, 2 years ago, found many exploitable segments, which increased deposits by 1.252 million tons. In researching the low angle faults in southwest Fujian, minable coal seams were found under multiple deformation reversals which increased many reserves, and this will not only change the course of enlarging coal reserves in Fujian, but these theories and applications will be instructional for many mining districts in the south. Many mining geology workers, in the course of their experience, summarized the similar and identical features of the extent, range, and volume of small structures within identical structural formations, applied the universal laws of combinations and distributions, and used the differentiations, displacements, dissociations, symmetry and conjugations of veins, and had rather good results in calculating the small structures, changes in coal thickness, shifts in coal rank, and distribution of gases.

It is not realistic for the mines in the south to resolve all of the complex geological problems before mining. In the process of drilling and excavation it is also very hard to do good calculations and predictions. There has been a rather good start, and it is believed that in time more data will be developed, on the basis of which, various new procedures will be found to integrate the special features of southern mines, and a full utilization of the relevant scientific theories will lead to various comprehensive analytic methods. That will be a fulfillment of the exhortation of China's elder mining geology professor, Deng Bang, "From formation analysis, mathematical analysis, causation enquiry, and background research a system of laws and logical interrelationship among geologic variables will emerge", and mining geology calculations and predictions will steadily move forward.

**Three-Part Plan for Oil Sector**

916B0039C Beijing RENMIN RIBAO HAIWAI BAN  
in Chinese 5 Feb 91 p 3

[Article by reporter Zhang Heping [1728 0149 1627]: "China Proposes Three Major Strategies for Petroleum Development: Stabilize Development of Old Oil Regions in East China and Accelerate Development of New Oil Regions in West China, Develop Oil and Gas Processing and Comprehensive Utilization and Strengthen the Petroleum Industry, Expand Economic and Technical Cooperation with Foreign Countries and Open Up International Petroleum Markets"]

[Text] China's petroleum industry, which has made enormous contributions to sustained, stable, and coordinated development of China's economy during the Seventh 5-Year Plan, has proposed "three major strategies" for achieving the magnificent goals of struggle for the Eighth 5-Year Plan and the next 10 years. I learned this at a meeting of leading cadres now being convened by the Petroleum Industry Bureau. The three major strategies for future development of the industry are:

1. Stabilize and develop production in old oil regions of east China, accelerate prospecting and development in west China, provide strategic replacements for oil and gas resources, achieve sustained and stable growth in crude oil and natural gas output throughout China. According to the clear requirements of central authorities for the petroleum industry, crude oil output must increase from 138 million tons in 1990 to 145 million tons in 1995. The China Petroleum and Natural Gas Corporation has decided that crude oil output must increase by more than 300,000 tons per year over the next 10 years and that we should strive for even more growth. East China, which accounts for more than 80 percent of our proven reserves and over 90 percent of our crude oil output, will continue to stabilize and increase output and will take on the heavy task of more than 80 percent of China's total crude oil output for the next 10 years. Exploration and development will be accelerated in new oil regions in west China, which concern near-term and long-term development of China's petroleum industry, especially Tarim Basin. Projections indicate that oil and gas reserves on a substantial scale will be proven in Tarim Basin during the Eighth 5-Year Plan and production capacity at a definite scale will be completed. We will continue to develop old oil regions in Sichuan and make major efforts to develop the natural gas region in Shaanxi, Gansu, Ningxia, and Xinjiang. There will be a substantial increase in China's natural gas reserves during the Eighth 5-Year Plan and good resource preparations will be made for development during the Ninth 5-Year Plan.

2. Strive to develop oil and gas processing and comprehensive utilization, strengthen the capacity for self-development in the petroleum industry. I learned that

based on this strategy, large and medium-sized oil refineries and heavy oil processing plants have been completed and are now under construction. They will focus on increasing product varieties and raising quality, doing good work to match up primary and secondary processing capabilities, develop intensive processing and fine processing, and attain or surpass advanced levels in China in product recovery rates, product varieties, product quality, and reducing energy consumption, and produce several high-quality, refined, and incisive products. Arrangements are now being made to build several ethylene plants that will import advanced equipment and be completed and go into operation according to plan. Over the next 5 years, several natural gas chemical industry base areas will be completed in many gas producing regions.

3. Actively expand economic and technical cooperation and exchanges with foreign countries, expand foreign trade of all types, strive to open up international markets. During the Eighth 5-Year Plan, the petroleum industry will adopt risky exploration and cooperative development, technical cooperation, joint investments to build plants, importing capital, importing technology and skilled personnel, and other arrangements to further expand its opening up to the outside world. Cooperation with foreign countries in regard to petroleum by 11 provinces in south China will adopt flexible policies. In addition, we will select several already developed regions and areas and new oil fields to prepare for construction to serve as a "window" for importing technology. We will also select several downstream projects and establish joint venture enterprises in China and foreign countries. Several petroleum enterprises will organize forces according to international standards, go to foreign countries for cooperative exploration and development, and actively undertake technical services, labor services, and contractual responsibility for projects. The Chinese Petroleum and Natural Gas Corporation pointed out that during the Eighth 5-Year Plan and the next 10 years, the main technology used in oil and gas exploration and development will approach or attain world levels and build our petroleum industry into a fully developed comprehensive industrial department centered on oil and gas production. The Chinese Petroleum and Natural Gas Corporation will become an international petroleum company with an excellent reputation and competitive capabilities.

**National Oil and Gas Survey Scores Significant Achievements**

916B0039B Shijiazhuang HEBEI RIBAO in Chinese  
5 Jan 91 p 3

[Article by reporter Zhu Youdi [2612 1635 2769]: "Outstanding Achievements in National Oil and Gas Survey, Several New Oil and Gas Fields Discovered, Will Provide New Oil and Gas Resource Base Areas"]

[Text] Outstanding achievements have been made in China's second petroleum and natural gas survey. Major

breakthroughs were made in prospective oil-bearing regions covering several million square kilometers and several new oil and gas fields were discovered or industrial oil and gas flows were drilled in succession in the East China Sea Basin, northern Tarim Basin, southern Songliao Basin, Henan's Dongming region, Anhui's Taihe region, the western Ordos Basin, the Subei [northern Jiangsu] region, and Sichuan Basin. They will provide new oil and gas resources for developing China's petroleum industry.

China's second large-scale oil and gas survey began in 1982. To shift the focus of its work toward energy resource geology, the Ministry of Geology and Mineral Resources decided to make new regions, new realms, new categories, and new depths important aspects of its second oil and gas survey. They assembled several 10,000 employees, 50 drilling teams, and six seismology teams and advanced toward the East China Sea, Tarim, Sichuan, southern Songliao, Ordos, North China, Jiangsu-Zhejiang-Anhui, central Hubei, Zhejiang, Guizhou, Turpan, South China Sea, and other continental and marine sedimentary basins. These drilling teams were equipped with advanced 9,000 meter and 6,000 meter drill rigs imported from foreign countries and all of the seismic teams were outfitted with advanced seismographs. All of the specialized geophysical exploration, geochemical exploration, aeromagnetic, remote sensing, and other field work teams also had completely new equipment and lineups compared to the first national oil and gas survey conducted in the 1960's.

The second national oil and gas survey, which submitted its first report in April 1983, indicated that the first high output oil and gas well had been drilled in the East China Sea. In the vast East China Sea, several oil and gas wells were drilled in sea bottom formations with moving names like Pinghu, Canxue, Yuquan, Tianwaitian, Baoyunting, and others. Among them, the Pinghu 4 well discovered 24 oil and gas strata 186 meters thick between 2,300 and 3,700 meters. Thus, they control some reserves in the Pinghu region. These survey achievements confirm the regional nature of oil and gas-bearing areas in the East China Sea and show that there is considerable potential for oil and gas.

To the west at Tarim was another battle in the second national oil and gas survey. Since the first high output oil and gas well was drilled in the Yakela structure in Kuqa County in September 1984, there have been continual new discoveries in the search for oil in the new realm of carbonate rock in the northern part. Unlike Daqing and Shengli oil fields and other regions of China, conditions in Tarim are even more difficult and the geology is extremely complex. Well depths exceed 5,000 meters. Another new oil-bearing stratum was discovered in the Yakela structure. Excellent oil and gas indications have also been discovered at a well drilled in the West Xayar structure.

High output oil and gas was obtained from the Sha 14 well in the Akkul region south of Luntai County in 1989,

indicating that oil and gas prospecting in northern Tarim has entered a new phase. The China Petroleum and Natural Gas Corporation has also drilled high output oil and gas wells in the Lunnan structure and Yingmaili structure. Tarim is an important replacement region for developing China's oil and gas resources, and it will have a major influence on future development of China's petroleum industry and national economic construction.

The experts said in assessment that the degree of exploration in most regions of China is rather low and geological conditions indicate that it will be extremely difficult to find large oil fields that are large in scale, reservoired at shallow depths, and have simple structures. Moreover, the geological and natural geographical conditions are complex in China's main prospective regions, and exploration costs will be high.

The second national oil and gas survey also completed 126 important scientific research achievements, 52 of which have received state or ministry S&T achievement awards. These achievements have played important roles in selecting regions, making deployments, and giving assessments in oil and gas survey work.

#### Achievements, Prospects for Oil, Gas Industry Recapped

916B0041A Hong Kong KUANG CHIAO CHING [WIDE ANGLE] in Chinese No 220, 16 Jan 91 pp 18-21

[Article by reporter Kou Wuxin [0656 0702 2946]]

[Excerpts]

#### Tarim Basin Began Shipping Out Crude Oil in 1991; Beijing Calls It "An Event of Important Significance"

It began in 1991—a vehicle loaded with Tarim Basin crude oil slowly departed the Gobi—the first outbound shipment of Tarim crude. Beijing Central TV broadcast the news on 1 January 1991, and stressed the important significance of the event. One of the world's very large oil fields was discovered at Tarim, Xinjiang, and it is already being exploited. People familiar with the current Chinese and world oil industries were drawn to this news, aware that the initiation of Tarim crude shipments is a matter of extraordinary importance. [passage omitted]

#### New Discoveries Capture World Attention

In 1989, the level of increase in oil and natural gas geological reserves that were prospected and brought under control surpassed 1988, as 11 large new oil and gas regions were explored and proved, capturing the attention of the world.

It is apparent from the official news released by the Ministry of Petroleum on the yield from Tarim, Xinjiang, that it could become the successor to the oil industry's most strategic region. In the Lunnan area of the northern basin, all of the exploratory wells have

yielded large oil and gas flows, or shown excellent signs of oil and gas, and one section has initially proven to bear oil and gas. In the central part of the basin, the first exploratory well (Tazhong-1) has uncovered a layer of oil over 100 meters deep. At Yingmali in the northern part of the basin, and in the Weimake area of the eastern part of the basin, high-yield oil and gas wells were verified, or showed signs of oil and gas. These oil and gas finds lends real hope that an especially large oil field has been found there.

Also, the Ministry of Petroleum has drilled quite high producing oil and gas wells at Yanshan and Yilahu in the Turpan Basin, and in the Chengdao area of the Shengli oil field in Shandong, and in the offshore river area in southern Liaoning two new oil fields of 100 million tons of reserves, and tens of millions of tons of reserves, respectively, have been found.

Natural gas exploration has also had noteworthy results as gas fields on a scale of over 10 billion cubic meters have been discovered in central and eastern Sichuan, in the central part of the Shaanxi-Gansu-Ningxia Basin, eastern Qaidam, eastern Junggar Basin, and in the Zhao district outside of Daqing. In Sichuan alone, 42 commercially valuable wells have been brought in, of which eight have daily yield of gas of over 1 million cubic meters, especially in the Dachigan well district in eastern Sichuan where a gas-bearing belt of natural gas reserves of tens of billions of cubic meters has been discovered. This could really put China in the forefront of the world in respect of volume of extraction.

In offshore oil and gas prospecting, Bohai, the East China Sea, the Pearl River mouth, and Beibu Gulf not only have rich medium-sized oil and gas fields been found, but large-scale oil and gas fields of reserves that surpass 100 million tons and 100 billion cubic meters respectively have been found. Three exploratory wells in the East China Sea—Pinghu-4, Canshui-1, and Baoyunting-1 wells—have brought up high flow volumes of commercially valuable oil and gas, and they prove that the continental shelf of the East China Sea has excellent potential for oil and gas. In the Yingge Basin of the South China Sea, the Ya 18-1-6 exploratory well was a success, and brought an increase to the Ya 13-1 gas field reserves of 30 billion cubic meters, and is a reliable basis for speeding up the development of Ya 13-1 oil field in the South China Sea.

In 1990 China's largest oil and gas bearing basin, the Tarim Basin, after the Lunnan-2 and Tazhong-1 wells yielded oil and gas flow, prospecting continued, and the Donghe-1 well also brought up a high volume flow of daily output of 879 cubic meters of crude oil.

Most recently, in the central part of the Shaanxi-Gansu-Ningxia Basin, the Shaan-5 well put out a daily flow volume of 1.1 million cubic meters of gas. The Huizhou 21-1 oil field, located in the offshore Pearl River mouth basin has been completed and put into production.

During the Seventh 5-Year Plan, the Chinese petroleum industry, working under difficult conditions, nonetheless maintained a steady growth. Throughout these 5 years, the Ministry of Petroleum, while carrying forth the consolidation adjustment of old oil fields, completed opening up the Guli oil field at Shengli, the Damintun at Liaohe, Huorao Shan in Xinjiang, Erlian in Nei Mongol, and the Duosikule oil field in Qinghai, which are just about ready to come on line. Chengbei in the Bohai, Huizhou 21-1 at the mouth of the Pearl River, among five other oil fields, are coming on line in turn.

In the 5-year period, newly constructed crude oil production capability was more than 80 million metric tons, and natural gas production capacity was 4.7 billion cubic meters. In 1990, crude production reached 138.25 million tons, and natural gas production reached 14.7 billion cubic meters. In the 5 years, crude production was 667.7 million tons, and production of natural gas was 70 billion cubic meters. Compared with the Sixth 5-Year Plan they represented increases of 23.5 percent and 13 percent respectively.

In 1990, production of crude at major producing oil fields was 55.65 million tons, where an annual production level of more than 50 million tons has been maintained for 15 years. Production of oil at Shengli oil field was 33.5 million tons, and compared with 1985 was an increase of 6.47 million tons, the highest rate of increase of any oil field in the country. The production of oil at Liaohe oil fields may reach 13.6 millions, an increase of 4.6 million tons over 1985, and moreover, China's largest heavy oil and high viscosity production base has also been completed there.

#### China's Oil Strategy for the Next 10 Years

According to forecasts from relevant departments, China's oil resources and deposits are 61.4 - 78.7 billion metric tons, and natural gas is 26 - 33 trillion cubic meters, and the proven reserves are only a very small portion of the forecasted volumes. The potential of China's oil industry is very great.

As to China's oil industry's prospects, most oil experts are especially optimistic. Information available to this writer shows that although the present Eighth 5-Year Plan for the oil industry has not been finally determined, after the National People's Congress in March of this year, it will be finalized, but the Chinese Oil and Gas Corporation has determined its strategic policy for the Eighth 5-Year Plan period, and its petroleum industry development for the next 10 years. It is this:

- Continue to maintain steady development of the eastern region. Strive to solidify the production base at eastern oil fields. Conduct further investigation of the oil rich belts in the old oil regions of Shengli, Liaohe, Zhongyuan, Dagang, and Huabei. At the same time, hasten the build-up of Chengdao and other structures as the main effort of prospecting the Bohai Gulf coastal and shallow seas areas.

- Accelerate oil and gas development and prospecting in the western region, especially Tarim Basin, and work for an early completion of large and especially large-sized oil fields there.
- Implement a policy regarding oil and gas as of equal importance. Bolster prospecting and development of natural gas. Open up new areas, correct the tendency to defer natural gas development and production in favor of oil development and production.
- Continue accepting foreign investments to speed China's offshore oil and gas prospecting and development, and strive to reach a production capacity of 5 million tons of oil and up to 120,000 tons of natural gas by 1992.

#### **Zhou Yongkang Looks Ahead to China's Petroleum Future**

The Vice President of the China Oil and Gas General Corporation, Zhou Yongkang, says that in the present world view, the struggle to control oil and gas resources intensifies daily; and the next 10 years is an important period in the development of Chinese petroleum. Despite restricted capital, and the many difficulties in production and construction, the prospects for development are very good.

In his evaluation and analysis of the next 10 years, old oil fields will still have great potential. Daqing, which produces 40 percent of the country's crude oil will certainly continue steady output until 1995, and even longer. Production at the various oil fields of the Bohai Gulf region, including Shengli, Liaohe, Zhongyuan, and Daqing which produce half of the oil in the country will continue to grow. The steadfastness of these old oil regions, which will be the foundation of the development of China's oil industry, is assured.

There will be a major breakthrough in the exploration of the western region. Not long ago in the Donghetang area of eastern Tarim, a sandstone oil deposit was discovered. The oil layer was more than 100 meters deep, and that presages a chance of finding several high yield oil fields. In the Turpan-Hami Basin an oil reserve of over 100 million tons has been found, and the range of oil and gas there continues to expand.

Natural gas prospecting is going well. In one 1,200 square kilometer area under investigation, not one exploratory well has come up empty, and the high daily output of uninterrupted flow has reached 1.1 million cubic meters, and another new gas area with a foreseeable potential has been found there.

Zhou Yongkang said that in the Eighth 5-Year Plan period China's oil industry not only can realize a good scale of reserves, but can build and create an genuine production capability, and it is estimated that by 1995 China's crude oil output could reach 140 million tons.

#### **1-Million Ton Heavy Oil Processing Facility in Karamay Fields**

*916B0039E Shijiazhuang HEBEI RIBAO in Chinese 26 Dec 90 p 3*

[Article by reporter Wei Haisheng [7614 3189 3932]: "Karamay Oil Field Completes 1-Million Ton Heavy Oil Processing Facility"]

[Text] Karamay oil field recently completed a specialized 1-million ton normal and reduced pressure heavy oil processing facility.

During the Seventh 5-Year Plan, Karamay oil field began extracting its heavy oil resources and has now produced a total of 4 million tons of heavy oil. The substantial increase in heavy oil output has put burdens and pressures on pipeline and railway transport. To alleviate this contradiction, Karamay oil field decided to build a specialized normal and reduced pressure facility to be used in processing heavy oil with a yearly processing capacity of 1 million tons that would enable local processing of much of the heavy oil produced at the oil field.

This 1-million ton heavy oil processing facilities was included among key state projects and it will have the largest processing capacity in west China.

#### **Oil, Gas Exploration in Anhui Enters New Phase**

*916B0019A Hefei ANHUI RIBAO in Chinese 15 Nov 90 p 1*

[Article by ANHUI RIBAO reporter Ni Zhimin [0242 1807 2404]: "Petroleum and Natural Gas Exploration and Development in Anhui Province Enter New Phase, Leading Experts Suggest Ways and Means, State and Local Areas Combine Forces"]

[Text] Complete success was achieved at the Anhui Petroleum and Natural Gas Exploration and Development Discussion Meeting, which has attracted attention throughout the province, and it closed on the afternoon of 14 Nov 90 in Hefei. This conference assembled the collective intellects of experts and professors and democratic decision making by leaders at all levels in one body. It actively combined the strengths of relevant departments of the state and local areas and achieved a common understanding of petroleum and natural gas concerning exploration and development of petroleum and natural gas. It showed that Anhui has excellent prospects for petroleum and natural gas development and that the pace of petroleum and natural gas exploration and development in Anhui should be accelerated.

Minister Tang Ke [0781 0344] of the former Ministry of Petroleum Industry, routine vice minister Song Ruixiang [1345 3843 4382] of the Ministry of Geology and Mineral Resources, chief geologist Yan Dunshi [7051 2415 1395] of the China Petroleum and Natural Gas Corporation, Anhui Province CPC leaders Lu Rongjing [4151 2837 2529], Bo Xishou [0590 6932 1108], Kang Zhijie

[1660 1807 2638], Long Nian [7893 1819], Zhao Huashou [6392 2037 1108], and Xu Shiji [1776 1102 1142] attended the meeting. Anhui Provincial Government deputy secretary Jiang Derong [3068 1795 2837] chaired the meeting.

Chief engineer Yan Dunshi pointed out at the meeting that this meeting held conscientious and lively discussions that were closely concerned with the exploration and development prospects for Anhui's petroleum and natural gas resources and the work focus, goals, and exploration and development prospects for the near term. It pooled the collective wisdom of the masses, suggested ways and means, combined theoretical explorations, practical experience, and leadership decision making into one body, and carried out conscientious debate and deployments for exploration and development of Anhui's oil and gas resources. The successes of the meeting were manifested in: 1) Summarization and review of the achievements and lessons from experience of geology and mineral resources and petroleum departments in the area of oil and gas exploration in Anhui since the 1950's; 2) Formation of relatively unanimous views through debate: Anhui has an important status in petroleum and natural gas exploration in east China. Anhui's position in overall plans for petroleum and natural gas exploration in all of China should be elevated and there should be new considerations and arrangements for exploration and development; 3) Preparatory work for oil and gas resource exploration in Anhui should be accelerated and inputs should be gradually increased. He pointed out that Anhui has good oil and gas resource prospects. We must first concentrate forces to focus on work to increase reserves and output in existing oil fields in eastern Anhui, strive to attain relatively rapid increases in output in the next 1 or 2 years, and make new breakthroughs in reserves. Northern Anhui has substantial coal-formed gas and natural gas resources and specific forces should be invested to organize exploration as quickly as possible. He also indicated that the China Petroleum and Natural Gas Corporation will provide the needed support for exploration of Anhui's oil and gas resources.

Vice minister Song Ruixiang stated at the meeting that this meeting achieved complete success. It not only clarified Anhui's oil and gas resource prospects but also made concrete deployments for exploration and development work over the next several years. The Ministry of Geology and Mineral Resources should make exploration and development of coal-formed gas in northern Anhui a key S&T project in the ministry during the Eighth 5-Year Plan and quickly compile oil and gas geology data for northern Anhui. The meeting also called for development work to be accelerated in other areas of Anhui Province.

At the meeting, comrade Tang Ke gave a speech brimming with warm feeling as an "old solder" on the petroleum battlefield. He said this meeting was a successful one. The meeting further clarified the prospects

for Anhui's petroleum and natural gas resources, clarified the focus of work, adhered to the principle of stability and action, and clarified the relationships among the "strategies", "campaigns", and "tactics" to develop Anhui's oil and gas resources. The entire meeting process embodied the spirit and style of comrades from all over China of "people in the same boat helping each other" to achieve the motherland's "four modernizations". He expressed his hopes that comrades at the meeting would continue to be concerned with and support oil and gas development in Anhui in the future.

Anhui governor Bo Xishou pointed out in his speech that assembling so many leaders and experts in a meeting helped Anhui study and debate petroleum and natural gas exploration and development issues, which was a grand occasion for the cause of petroleum and natural gas exploration in Anhui and a great event in the economic life of all of Anhui Province. This meeting clarified the directions and focus of work in Anhui's oil and gas exploration and provided a reliable foundation for compiling and implementing exploration and development plans during the Eighth 5-Year Plan, and it obtained concrete implementation for many questions. This meeting indicates that oil and gas exploration and development in Anhui have entered a new phase. He stressed that petroleum and natural gas exploration and development are major concerns that we should work to do well. Breakthroughs in this area will certainly inject new vigor and vitality in Anhui's economic development and provide a new point of support for the strategic decisions on "development in Anhui and Jiangsu" made by the Anhui Provincial CPC Committee and Provincial Government. He called on all levels of government in Anhui to create an excellent environment for petroleum and natural gas exploration and development and to provide services wherever the drill rigs were drilling. Leaders, engineering and technical personnel, and all employees in Anhui's petroleum exploration departments should take full advantage of the conditions provided by the state and province, work even harder and do solid work, and make new contributions to the cause of petroleum and natural gas exploration and development.

### Prospects for Developing Liquefied Natural Gas Industry Described

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[Article by Zheng Dazhen [6774 1129 2182], Central China Institute of Science and Engineering, and Li Qun [2621 5028], Changjiang Power Company: "Prospects for Developing China's Liquefied Natural Gas Industry"]

[Text] Abstract. A summary of world energy development trends and China's energy situation indicates that natural gas will have an important role in China's future energy structure. Gradually establishing the technical

facilities for a liquefied natural gas (LNG) industry in China is an important measure for developing its natural gas industry. The resources, technologies, markets and funding needed for the purpose are analyzed. A three-stage model for the development of the industry is suggested. The immense domestic potential should be utilized by means of a unified program.

#### **Natural Gas Will Occupy an Important Position in China's Future Energy Structure**

World energy consumption inevitably develops from a low stage to a high stage. One the one hand, this is expressed as an increase in demand, and on the other as a changeover from inferior-quality energy (wood, coal) to superior-quality energy (petroleum, natural gas, nuclear power and the like). Improved production capabilities, transformation of the social and economic structure, and improvement of the people's standard of living will greatly increase the need for superior-quality gas and liquid fuels. This is the irreversible, universal trend of energy replacement.

China's energy consumption is essentially still in the basic construction stage. It will be seen from Table 1 [1] that we are the only one of the world's major energy-consuming countries that relies primarily on coal. We can foresee that as society develops, there will ultimately be changes in this energy consumption structure. We have the prerequisites for self-reliance and the objective basis for promoting this changeover. Natural gas is the replacement strategic resource that is most suitable for development.

Although China's natural gas industry has developed greatly since liberation, various factors have made its development extremely slow, and in the last 10 years it has actually been stagnant: it has not yet reattained its historic level of 1979 [5, 7]. Comparison with world figures indicates that our oil and gas output ratio is greatly out of balance. Currently, the world oil-to-gas output ratio is 1:1; the figure for the U.S. and the Soviet Union is 0.85:1, while that for China is 10:1 [2, 3]. World average figures indicate that China's average output will be able to reach 8 billion cubic meters per year; if so, then the problem of upgrading the supply of energy for urban civilian uses and providing essential industrial gaseous fuels and organic chemicals will be greatly alleviated.

The reason that we fall so much short of world standards is not that we lack the resources: actually, China has an excellent geological basis for natural gas and superior conditions for the rapid development of its natural gas industry. According to reliable calculations by the petroleum and mining departments, our natural gas reserves total 15 to 33.3 trillion cubic meters, putting us in the world forefront and making us a gas-rich country. But China's explored reserves are very small, far smaller than its explored reserves of petroleum [3]. A comparison with the Soviet Union, the United States and Canada indicates (Table 2 [2]) that we are capable of achieving

explored-reserve levels of 2.7 to 17.4 trillion cubic meters. Specialized documents [3, 5] also provide a detailed analysis of the evidence that China has abundant reserves of natural gas. These documents all state that China has extensive areas of continental-facies sedimentary rock and favorable geological conditions for the formation of large and medium-size gas fields; natural gas occurs extensively in all sequences, and gas pools or fields have been discovered in most sequences; coal resources are abundant, forming the geological basis for large-scale conversion of coal to gas fields; the Qaidam and Song-Liao basins, such coastal zones as the Bohai Sea, and basins such as Yinggehai, the East China Sea and the northern zone of the South China Sea have extensive biological gas showings.

There are many reasons that China's natural gas industry developed slowly, but the principal one is an inadequate recognition of the important role that it will play in the economy. In real terms, this has been expressed as: limited investment in and performance of natural gas exploration in the early period; a failure to provide a full complement of handling and processing facilities in the middle period; and an inadequate management system in the late period, together with an irrational pricing system that creates difficulties for accumulation and development. Now, however, the energy departments have accorded a high priority to accelerating the development and utilization of natural gas, and they are taking steps to reverse this passive situation. We may predict that natural gas will occupy an important place in China's future energy structure.

#### **Brief Survey of the Development of the World Liquefied Natural Gas (LNG) Industry**

The principal component of natural gas is methane, whose density is about half that of air, with a boiling point of -161°C at normal pressure. It has been called a clean fuel; it has high calorific value, produces little pollution, and is convenient to use. Liquefied natural gas has only 1/625 the volume of the original gas, which is an outstanding advantage for the storage, transport and rational utilization of natural gas.

Natural gas liquefaction technology began at the time of World War I. The objective then was not to obtain LNG products, but to obtain helium after liquefying natural gas in cooling facilities. The characteristics of natural gas after its liquefaction gave rise to an interest in LNG products, and in 1941, the world's first commercial-scale LNG facility was built in Cleveland (US). Its liquefaction capacity was 8500 cubic meters per day, and it had a storage tank capacity of 34,000 cubic meters. Starting in the 1960's, the LNG industry developed extremely rapidly abroad. In 1964 the first large-scale LNG facility, designed in France, was commissioned in Algeria, and the first transport in large tanker ships was instituted. Thereafter, LNG facilities developed even more rapidly and increased in scale. The capacity of the main facilities was more than 25,000 cubic meters per day. More than 160 LNG facilities are now in operation worldwide.

Total LNG exports exceed 46.18 or 73 million tons per year. There are already more than 10 navigation routes and handling facilities linking Algeria with the United States, Algiers and Libya with Europe, and Alaska with Japan. The capacity of LNG storage tanks has also been steadily increasing; the largest such tanks are up to 100 meters in diameter and 30 meters high, with capacities in the tens of thousands of tons [6, 11].

Participants in an international low-temperature engineering conference held in Los Angeles in 1969 [4] concluded that the development of the LNG industry constitutes a revolution in the natural gas industry which is likely to alter the industry's structure and has the potential to be comparable with the scale of the world fuels trade [as published]. This opinion was accepted by many energy experts and government officials, for the following reasons. 1. About a quarter of world hydrocarbons are in gaseous form, and there are abundant resources of natural gas. 2. Natural gas-producing areas are generally far from energy-consuming areas, and LNG is the most economical and convenient form of gas transport. 3. Atmospheric and environmental protection has become a global problem, and in particular, natural gas is a cleaner fuel than gasoline for major industrial and population centers. 4. In addition to serving as an energy source, it is also a valuable low-temperature coolant. The rapid development of the world LNG industry has demonstrated the correctness of the above assertions. They can also serve as valuable reference data for China's development of an LNG industry.

#### **Developing LNG Technology Is an Important Way of Accelerating the Development of China's Natural Gas Industry**

The processing and utilization of natural gas in China faces many problems. On the one hand, natural gas is in short supply, and there are many conflicts between production and sale. On the other hand, large amounts of natural gas are simply discharged into the atmosphere or burned in flares, there are serious cases of inefficient or illegal use of gas, and there is a great deal of waste. Production currently is limited to extraction of the heavy-hydrocarbon component (light gasoline, liquid petroleum and the like), and its short-range pipeline transport. Owing to the lack of a full complement of collection and transport facilities and handling and processing equipment, only about 30 percent of natural gas is processed [7].

Developing LNG technology, gradually building a full complement of LNG facilities, and developing China's LNG industry will result in better utilization of existing natural gas resources. The reasons are as follows.

1. Large and medium-size LNG plants serve as a new type of centralized, stable energy supply plants, with a buffer supply to meet peak demand, and are able to assure a secure and reliable supply of gas to downstream projects.

2. Medium-size and small fully equipped LNG facilities can be installed on site and put rapidly into operation, thus beginning the utilization of underground natural gas resources as rapidly and fully as possible, which is in keeping with China's energy development guidelines.

3. Truck-mounted or boat-mounted mobile LNG plants can conveniently perform motorized collection of natural gas from remote oil and gas fields, thus providing an effective way of developing deep-sea or back-country natural gas fields.

4. The use of motorized surface transport to replace long-distance underground pipeline transport is convenient and reliable and can decrease large risky investments by the users.

5. The cost of storing LNG is only 1/6 to 1/70 that for storage of the original gas, which offers the advantages of lower investment costs, smaller site requirements, and greater storage capacity, which are in line with China's circumstances.

6. Widespread use of LNG as a new motor-vehicle fuel in China would be advantageous because of its small volume, the light weight of the storage tanks that would be required, and the longer vehicle ranges that would become possible, and would decrease transport costs and result in a major increase in the value of the natural gas, thus providing significant economic benefits. In addition, it would decrease environmental pollution (since cars using this type of gas would not emit poisonous lead and black smoke), and would alleviate the domestic gasoline shortage, thus achieving three objectives at one stroke.

7. At least 50 percent of the energy used in the liquefaction of natural gas is recovered; use of the cooling capacity of the natural gas in the course of reheating it could help to develop cold storage, refrigeration, air conditioning, low-temperature fracturing, cold electric power generation and the like.

8. The output of a large-size LNG industry could be exported in order to earn foreign exchange (Japan is the world's largest LNG importer).

To summarize, developing LNG technology and gradually establishing a Chinese LNG industry is a major measure that is consistent with China's natural gas development prospects and will accelerate the development of the natural gas industry.

#### **Conditions for Successful Development of China's LNG Industry**

Any successful industry has four basic requirements, namely, materials, technology, markets, and funding. All of these four conditions for the development of an LNG industry in China can be met.

##### **1. Gas Resources**

China has abundant natural gas resources, as noted above. Simply stepping up expenditures on preliminary work will undoubtedly cause the exploration of natural gas resources to make major progress. The many recent reports of discoveries of offshore and continental gas fields clearly demonstrate this point.

## 2. Technology

LNG technology includes five components: preprocessing, liquefaction, storage, transport, and utilization.

China has already reached maturity as regards preprocessing: large and medium-size oil fields have already established several dozen crude oil stabilization facilities, and we also have a strong technology background in light hydrocarbon recovery. More than 30 gas processing facilities have already been constructed [7]. We have the technology and the production capacity to supply sets of preprocessing equipment.

China already has relatively mature experience in the design and construction of low-temperature liquefaction, storage and transport facilities and has a solid, well-rounded technology contingent. Large and medium-size air separation facilities are already located throughout the country. Liquid oxygen, liquid nitrogen, liquid hydrogen and liquid helium flowcharts are in operation in many locations, and there is abundant experience in their management. Most of the components of LNG facilities can be transferred directly or with slight modification from existing deep-cooling facilities. We have experience in the manufacture and transport of medium-size and small low-temperature liquid storage containers, and many plants throughout the country are producing and using a variety of low-temperature containers designed for lower liquefaction temperatures than those used with LNG.

Fully reliable data on the physical and heat-transport properties of the various components of natural gas, together with the relevant equations for use in the design of LNG facilities and processes, are available. Large bodies of detailed information on LNG process flowcharts and the design of large LNG storage tanks and tanker ships are available abroad. The large body of research results and other data regarding the safety of LNG will be able to allay any uncertainty or concern regarding the production, storage, transport and utilization of LNG [10, 12].

The technological problems of the use of LNG in motor vehicles have already been solved, and the technology has passed an evaluation conducted by the Henan Science and Technology Committee on behalf of the State Science and Technology Commission. LNG-powered vehicles have been put into operation in Kaifeng and have already given more than 4,000 kilometers of safe service. Evaluation data indicate that the use of LNG containers in place of large gas tanks increases vehicle range by a factor of 6, produces good economic benefits, and is safe and reliable, while producing less pollution

than gasoline. The use of LNG has been well received by drivers and passengers and by the transport and environmental departments.

## 3. Markets

China's energy and transport shortages are becoming steadily more acute, and the petroleum industry is far from being able to meet the economy's steadily growing demand. Our coal-based energy structure is producing many difficulties involving environmental pollution. Developing the LNG industry will enable us to make thorough, rational use of China's natural gas resources and is sure to inject new vitality into China's energy markets. Other countries have dealt with pollution problems resulting from municipal transport by promoting large-scale use of natural gas in rental cars (in Japan) and in buses (in the US, Italy, Canada and elsewhere); and this example alone indicates that China's LNG market will be sizeable.

## 4. Funding

In the long term, building a large-scale, fully equipped liquefaction, storage and transport system will be necessary in order for China to develop its natural gas industry. But at present we are not in a position to do all of these things, because we lack data for the correct siting of large and medium-size gas fields and rather large one-time investments are required. In this respect, we can deal with the problems when the conditions are ripe, and we can bring in foreign investments when necessary.

In China's current real circumstances, there is still funding to be found for research on LNG technology and for establishing medium-size and small liquefaction, storage, transport and utilization systems. These efforts not only will provide a technology reserve, but in addition are urgently needed. On the one hand, we will rely on suitable centralized state funding to support technology development and applied research in this field; in addition, the LNG industry, which is an integrated body that spans the energy, petrochemicals, machinery and communications departments, should mobilize personnel in all relevant departments and designate rather large system investments for distributed contracting and dispersed efforts, with joint use of the benefits. The state will offer preferential terms as regards policy, taxation, and pricing. This will make it possible to alleviate the difficulties resulting from the shortage of funds. In the short term, the recovery of natural gas that is now being discharged into the atmosphere should be the province of the departments and units engaged in promoting LNG-powered motor vehicles, and every effort should be made to promote their expanded reproduction in order to accumulate larger amounts of funds for the long-term development of the LNG industry.

## Prospects for the Development of China's LNG Industry

In order to accelerate the development of China's natural gas industry, while greatly intensifying the investments and effort devoted to preliminary o73 development of

natural gas and strengthening the effort to find large and medium-size gas fields, we also should incorporate the LNG industry into the overall program of the natural gas industry, draft realistic long-term development policies, and provide development funds and organizational measures. It must be realized that the LNG industry is an entirely new system in China that has numerous components, including design, equipment manufacture, production, storage, transport and utilization, and that it requires a specialized organizational structure for program development and management.

The future course of the LNG industry in China can be divided into the following major stages.

1. Establishment of small LNG facilities, finalized design of a full complement of storage tanks and gas trucks, including liquefied-gas containers, construction of dispersed filling stations, and promotion of the use of LNG-powered motor vehicles in large and medium-size cities that are in a position to do so. Concurrently, large-scale development and rapid installation of LNG facilities to recover gas from remote gas fields and gas that is currently being discharged into the atmosphere.

2. Design and assembly of equipment for small-scale LNG facilities that make use of the advanced propane-mixed coolant process flowchart [8, 10], and establishment of a medium-size storage-tank and transport network, in order to work gradually toward a stable supply of LNG.

3. Construction of large LNG plants and tanker ships and the manufacture and use of large LNG storage tanks; the construction of deep processing plants making use of LNG at locations that are convenient for water and land transport; and promotion of the use of LNG as a fuel in inland river transport and aviation, so that natural gas resources will be more thoroughly utilized and urban pollution will be further alleviated.

In the above three stages, while considering the importation of advanced foreign equipment and foreign funds, we must bear in mind China's huge potential in low-temperature technology. The use of existing domestic equipment and technical manpower would be entirely sufficient to bring Chinese technical facilities for LNG into being within a short time.

Developing the LNG industry and expanding the range of applications of LNG products will promote the development of the domestic natural gas industry, and as environmental awareness increases and currently untapped natural-gas supplier areas enter the market, China's natural gas industry will quickly take on a new look.

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#### Qinghai's Crude Output Sets Another Record

916B0039A Xining QINGHAI RIBAO in Chinese  
12 Dec 90 p 1

[Article by special reporter Yang Haiping [2799 3189 1627] and reporter Li Feng [2621 1496]: "Crude Oil Output in Qinghai Province Sets Another Historical Record, Annual Crude Oil Output in Latter Part of Seventh 5-Year Plan is 3.6 Times Annual Crude Oil Output in Latter Part of Sixth 5-Year Plan"]

[Text] By the end of November 1990, crude oil output in the Qinghai Petroleum Management Bureau during 1990 had surpassed 725,900 tons, setting another new historical record high over the 1989 figure of 725,046 tons. This was the fifth consecutive year that a new annual crude oil output record was set at Qaidam oil field since the start of the Seventh 5-Year Plan. Statistics show that total crude oil output in this bureau over 4

years and 11 months of the Seventh 5-Year Plan surpassed 3 million tons, equal to 77 percent of total output over the 30 years preceding the Seventh 5-Year Plan. Annual crude oil output during the latter part of the Seventh 5-Year Plan was 3.6 times the annual crude oil output during the latter part of the Sixth 5-Year Plan.

Besides using a small amount of the crude oil produced by this bureau during 1990 to complete the processing plan for the oil field's oil refinery, it mainly went to guarantee the needs for normal out-shipments via the "Huage" oil transmission pipeline. In an unfavorable situation of policy-related losses in China's petroleum industry due to the price system and other factors, the 20,000-plus employees in the Qinghai Petroleum Bureau took the overall situation into consideration, helped the country with its difficulties, and undertook two rather large scale battles to raise crude oil output in early 1990 and during the third quarter of the year. Everyone from cadres in organs at all levels to engineering and technical personnel as well as workers at their posts worked to increase production. They placed new wells into operation and worked on various tasks in the battle like installing water injection and water removal projects on oil pumps, laying out pipeline networks, perforation, well repair, and so on, and all were completed on schedule with quality guarantees. The bureau's oil extraction plant imported advanced pressure cracking equipment from foreign countries and tested pressures at four wells in the Gasi oil field. Daily crude oil per well increased by a maximum of more than 50 tons. With assistance from fraternal units in Qinghai and other provinces, communications facilities, reserve power stations, and other construction projects at the oil field also kept up with the pace of rising output at the oil field. Since the fourth quarter of 1990, daily crude oil output levels at the oil field have basically been held stable between 2,600 and 2,750 tons. If no unexpected circumstances happen in crude oil transport, they may surpass 800,000 tons by the end of 1990 and exceed their quota in state plans.

Officials in the oil field's marketing department said that a total of 430,000 tons of crude oil was sold outside Qinghai during the first 11 months of 1990. With substantial assistance from Golmud City and railway departments, and with joint efforts by employees in the Northeast China and East China Oil Transmission Bureaus, the Langfang Pipeline Bureau, and the Qinghai Oil Field Oil Transmission Pipeline Office, from the time that the "Huage" oil transmission pipeline was successfully returned to operation transmitting oil from 28 Sep 90 to now, a total of 144,448 tons of crude oil was loaded onto trains and shipped out from Golmud City.

#### **Huge Reserves Verified in Chang Jiang Basin**

916B0019B Shanghai WEN HUI BAO in Chinese  
15 Oct 90 p 1

[Article by Niu Weigong [6873 1919 1872]: "Huge Potential Oil and Gas Resources in Chang Jiang Basin, Oil and Gas Exploration in China May Shift to Marine Facies Realm"]

[Text] A major achievement in state attacks on key S&T problems during the Seventh 5-Year Plan which recently passed examination and acceptance in Nanjing indicates that there are huge potential petroleum and natural gas resources and broad prospects for oil and gas exploration beneath the ground in the Chang Jiang basin, and that it will become a strategic goal in the shift of oil and gas exploration in China from the continental facies realm to the marine facies realm.

Over one-half of the world's oil and gas resources are contained in marine facies carbonate rock strata, which are strata composed mainly of limestone that was deposited and evolved in an ancient marine environment. China has about 3 million square kilometers of this category of strata, equal to one-half of the area of sedimentary rock in China, but the oil and gas reserves that have been proven in it account for less than 5 percent of our total national reserves. The Yangzi region, which covers an area of about 1.5 million square kilometers, includes almost the entire Chang Jiang basin extending from eastern Yunnan to Shanghai. There is widely distributed marine facies carbonate rock beneath it, making it an important realm which is conducive to the generation and accumulation of oil and gas. To open up this new realm for oil and gas resources, China has organized state projects to attack key S&T problems to solve this question. On the basis of major progress in attacks on key problems during the Sixth 5-Year Plan, the Ministry of Geology and Mineral Resources which is responsible for this task organized a major project called "Research on Yangzi Marine Facies Carbonate Rock Region Oil and Gas Exploration Technology and Evaluation" during the Seventh 5-Year Plan. It organized 51 units and over 1,200 scientists and key technical personnel to participate in a multidisciplinary and multi-layer integrated body that combined scientific research, surveys, and education.

More than 100 effective oil and gas traps (areas conducive to the accumulation of oil and gas) have been verified so far, covering an area of 1,000 square kilometers. This includes three oil and gas discovery wells in the upper Yangzi region, dominated by Sichuan Basin, which may control projected natural gas reserves of as much as 100 billion cubic meters; the central Yangzi region, dominated by Jianghan Basin, where traps covering an area of about 150 square kilometers have been discovered and confirmed in a preliminary manner; and the lower Yangzi region, dominated by the Subei [northern Jiangsu] Basin, where regions and blocks with different oil generation conditions have been pointed out, confirming that the Nanjing-Nantong region is a favorable oil and gas accumulation region. Many types of oil and gas indications and small oil and gas flows were discovered in several wells. These achievements opened up a development base area for the Eighth 5-Year Plan and even longer term oil and gas exploration. The attacks on key problems also pointed out new theories and new ideas for oil and gas exploration in a complete set of marine facies realms and formed in a preliminary

manner China's own unique complex marine facies realms oil and gas geology theory system.

### Growth in Xinjiang's Oil Field Production Reported

916B0041B Shanghai JIEFANG RIBAO in Chinese  
20 Jan 91 p 3

[Text] In the Seventh 5-Year Plan a geological reserve was found at Karamay oil field, production capability was built, crude oil output increased in turn, and development proceeded smoothly. During the Seventh 5-Year period the Xinjiang Petroleum Administrative Bureau saw many new proven geological reserves brought in. In the Beisantai area of eastern Junggar Basin, closer in and beyond the old oil fields on the northwest rim of the basin, oil reserves have been found, and on and within the southern rim, new areas have been opened up for prospecting.

The period from 1986 to 1990 was the fastest period of development in Xinjiang. The scale of construction of production capability surpassed that of any previous 5-year plan. Throughout these 5 years, the Xinjiang Petroleum Administrative Bureau opened up the Huoshao Shan oil field, the Zhongyou oil field, and 70 new sites and new strata for a grand total of constructed capacity of 5.65 million metric tons; 140,000 tons over quota.

The increase in geological reserves and construction of production capacity tasks that have been completed over quota have pushed a sustained growth in crude oil production volume. During the Seventh 5-Year Plan the cumulative production of crude oil in Xinjiang was 30.61 million metric tons, an increase of 41.5 percent over the Sixth 5-Year Plan. Production of crude increased from 4.99 million tons in 1985 to 6.8 million by 1990, a net increase of 1.81 million tons. In this 5-year period production of crude from Xinjiang oil fields showed an average annual increase of 6.3 percent, which was above the national average.

### Big Oil Field Discovered in Turpan-Hami Basin

916B0044 Beijing RENMIN RIBAO in Chinese  
2 Feb 91 p 1

[Text] A large oil field has been discovered in the Turpan-Hami Basin in the eastern part of the Xinjiang Uygur Autonomous Region and it is expected that in the near future a large-scale crude oil production capability will be created.

The Turpan-Hami Basin is one of the large oil and gas-bearing sedimentary basins in western China. It has a total area of 48,000 square kilometers. In recent years, the petroleum sector through digital seismic exploration and drilling, has discovered 10 geological structures favorable for the exploration of oil and natural gas. Moreover, in two of the structural belts, wells were

drilled producing industrial grade crude oil. A considerable area of oil-bearing structures and reserves were discovered and verified, thus creating a bright future for development.

Today, drilling and exploration work is concentrated in the Qiuling-Shanshan structural belt, covering an area of about 1,000 square kilometers. So far, 15 test wells have produced industrial grade oil or have good indications of the presence of oil and natural gas, proving that the area is a multi-strata, multi-system oil and natural gas collection area. China's first large Jurassic system oil field has been verified and discovered in the Shanshan area. In an exploratory well drilled in the Qiuling area, the oil layer thickness is about 125 meters on average, with the thickest at 238 meters. After testing, it was found that a single well yielded 121 cubic meters of crude oil and 17,000 cubic meters of natural gas a day. According to the forecast of geologists, oil fields bigger than the ones in Shanshan may be found here and it is quite possible that the oil layer may be connected to the oil layer of the Shanshan area.

Exploration work in the Turpan-Hami Basin is being expanded. Two new structures have been discovered in the Qiuling-Shanshan structural belt, oil layers of 90 meters and 100 meters respectively. In the western part of the basin, industrial grade oil flow has been obtained in the first exploratory well. In the eastern part of the basin, indications of oil and natural gas have been obtained in drillings.

According to reports, the oil fields discovered in the Turpan-Hami Basin are only 7 kilometers from the Southern Xinjiang Railway and only 170 kilometers from Urumqi. Moreover, the oil layer is close to the surface. The oil is of superior quality and is favorable for development. The China Petroleum and Natural Gas Corporation has set up a command post in the basin and has deployed some 14,000 workers from the Yumen, Changqing, and northern China oil fields to the basin to start work.

### Jilin's Crude Production Continues To Climb

916B0039F Changchun JILIN RIBAO in Chinese  
4 Jan 91 p 1

[Article by Wang Youmin [3769 1635 3046], Zhang Wenbin [1728 2429 1755], and Ma Xinhong [7456 2946 5725]: "Crude Oil Output Continues To Grow at Jilin Oil Field, It Is First Among China's Eight Big Oil Fields in Degree To Which Quotas Exceeded"]

[Text] A big petroleum army of 50,000 at Jilin oil field, one of China's eight big oil fields, fostered the enterprising spirit of "arduous struggle, sustained development, taking initiative in increasing pressure, and contributing more" during the final year of the Seventh 5-Year Plan. They overcame a reduction in the ratio between extraction and reserves, rising production costs, severe shortages of construction capital, and other problems, and produced over 3.55 million tons of crude oil,

which was 6 percent over their quota in state plans, the largest amount by which quotas were exceeded among China's big oil fields.

During the Seventh 5-Year Plan, Jilin focused on exploration and applied new theories and new methods to discover five oil pools, Sifangtuizi, Haituozi, Sijiazi, Changchun, and Xinmin, in the southern part of Songliao Basin, Jiayi graben, and other key exploration regions that increased their geological petroleum reserves by 90 million tons.

In the area of oil field development, they developed and built three new oil fields at Qian'an, Yingtai, and Changchun with high levels, high speed, and high quality. They also started pushing forward with an energy production construction project at Xinmin oil field. Readjustment, expansion of boundaries, additional measures to increase oil well output, and other work at old oil fields reinforced effective water injection and comprehensive exploitation of potential and achieved stable output. Over the past 5 years, deformation of casing pipe was dealt with at a total of 387 oil wells that reduced losses of crude oil output by 91,000 tons.

In the area of oil field construction, construction staffs expanded from simple oil construction and installation into comprehensive construction staffs capable of taking on refining and chemical construction. Full-staff labor productivity rose from 9,506 yuan to 24,980 yuan, setting the highest level in Jilin.

All oil field employees established a sense of being the masters of their own affairs and consciously turned pressure into motive force, and several collectives and individuals appeared which thought like masters, worked like masters, fulfilled their duties as masters, and assumed the responsibility of masters.

Crude oil output at this oil field rose from 2.13 million tons in 1985 to 3.55 million tons in 1990, an average

yearly increase of 280,000 tons and a yearly growth rate of 10.5 percent, the leader among China's eight big oil fields.

#### **Another Big Gas Field Discovered in Qaidam**

*916B0039D Shijiazhuang HEBEI RIBAO in Chinese  
26 Dec 90 p 3*

[Article by reporters Yang Xinhe [2799 2450 3109] and Wang Ding [3769 0002]]

[Text] We learned from the Qinghai Petroleum Management Bureau's geological prospecting departments that abundant natural gas resource reserves have been proven in the eastern part of Qinghai's Qaidam Basin. The reserves exceed 30 billion cubic meters, making it one of China's largest natural gas fields.

The information indicated that the newly-discovered gas field is in Quaternary system strata between Tainan and Sebei in eastern Qaidam. Gas has already been found in several wells drilled in this area. The initial assessment by experts is that this formation is characterized by being from a recent era and has loose strata, shallow gas strata, high output, very thick gas strata, and so on. Prospective reserves will exceed 30 billion cubic meters, so it has substantial industrial use value.

The geographical environment of the newly-discovered gas field is superior to the Gobi Desert region to the west and the transmission distance would be shorter. It will play an active role in developing the civilian and chemical industries in Qinghai and Tibet.

Qaidam Basin, which covers a total area of 120,000 square kilometers, has Cenozoic sedimentary rock covering an area of 96,000 square kilometers. The maximum sediment thickness has already been proven to be as much as 16,000 meters, and there are widespread oil and gas indications. A total of 17 oil fields and five gas fields have already been discovered there.

**Nuclear Industries Entering a New Era**

916B0043A Nanchang JIANGXI RIBAO in Chinese  
28 Jan 91 p 3

[Article by reporter Hu Nianqiu [5170 1628 4428]: "China's Nuclear Industry Entering New Stage Focused on Development"]

[Text] Over the next 10 years, China's nuclear industry will be readjusted to a new system that is focused on development and combines military and civilian uses, makes deployments, lays foundations, raises levels, increases benefits, and reinforces strengths and reserve strengths.

This was revealed by a press spokesman from the China Nuclear Industry Corporation on 26 Jan 91. He said that future development of China's nuclear industry will be carried out in three stages:

Stage 1, from 1991 to 1992, will mainly involve further work at improvement and rectification and intensified reform. The Qinshan first phase project and Daya Bay No 1 generator will be completed and they will be connected to grids and generate power, achieving a breakthrough in the total lack of nuclear power on the Chinese mainland. Consolidation and development will be achieved in developing and applying nuclear technology and in improvement and rectification of civilian product production.

Stage 2, from 1993 to 1995, will see the further unfolding of nuclear power construction. Construction of the two 600MW generators in the second phase and the 300MW generator in the minor second phase at Qinshan will enter the peak period and the No 2 generator at Daya Bay will be completed and generate power. There will also be rather substantial developments in the application of nuclear technology in all realms of the national economy and economic diversification to form certain pillar products and pillar industries.

In Stage 3, from 1996 to 2000, nuclear industry construction will involve completion of several nuclear power plants with an installed generating capacity of about 6,000MW, corresponding development of uranium ore resources and the nuclear fuel industry for nuclear power, further expansion of the nuclear technology industry, and economic diversification to form scale economies and stable development.

**Assuring a Stable Fuel Supply for Nuclear Power**

916B0035A Shanghai WEN HUI BAO in Chinese  
13 Dec 90 p 1

[Article by reporter Xu Daoli [6079 6670 4409]: "Progress Made in Converting Thorium Into Uranium-233, Research By Zhang Jiahua [1728 1367 7520] and Others at Shanghai Atomic and Nuclear Institute Passes Examination and Acceptance, Timely Stable Supplies of Fuel To Develop Nuclear Power"]

[Text] Nuclear physicist Zhang Jiahua, the well-known director of the Shanghai Atomic and Nuclear Institute, led a group of middle-aged and young intellectuals in 10 years of research on ways to use thermal neutron radiation to convert thorium into the fissionable fuel uranium-233. They obtained much important data during their experiments and summarized laws. This was the first project to study this topic in China and it has now passed examination and acceptance by experts.

Nuclear fuel is essential for developing nuclear power. Most of the world's use of fission nuclear energy to generate electricity utilizes the naturally- occurring fissionable fuel uranium-235. China has limited uranium resources, however, so it has been extremely urgent and important that we seek artificial ways to produce fissionable fuel to achieve long-term stable development of nuclear power.

Thorium occurs in the natural world as a single isotope, thorium-232. It is not a fissionable fuel itself, but it is converted into uranium-233 when it absorbs neutrons and becomes a very good fissionable fuel. Thus, thorium is a latent energy resource and China has extremely abundant thorium resources that provide the conditions for using thorium. The experts gave high marks to this research achievement and feel that it has reliable experimental data and rational analysis. This was a major achievement with profound significance and applications prospects for developing nuclear power.

**Update on FBR Research, Future Plans**

916B0035C Wuhan HUBEI RIBAO in Chinese  
20 Nov 90 p 3

[Article by reporter Jiang Zaizhong [3068 0961 1813]: "China Fast Reactor Research Center Established, Indicates China's Peaceful Use of Atomic Energy Technology Has Entered New Stage"]

[Text] If it can be said that construction of the Qinshan and Daya Bay pressurized-water reactor nuclear power plants indicates that China has begun to develop nuclear power, then establishment of the China Atomic Energy Scientific Research Academy's Fast Reactor Research Center in Beijing on 19 Nov 90 indicates that China has entered a new stage in the peaceful use of atomic energy technology.

State Council member Song Jian [1345 0256] attended the founding ceremony and gave a speech. He said that construction of the Fast Reactor Research Center is an important milestone in China's research on the peaceful uses of atomic energy and that it will certainly play a major role in the second generation of nuclear power research and construction in China. He have lofty praise to the prominent achievements of the China Atomic Energy Scientific Research Academy in developing China's atomic energy technology and called on them to make even greater contributions to mankind and the peaceful use of atomic energy.

The Fast Reactor Research Center mainly includes a fast reactor experimental facilities project and an experimental fast reactor. The 20MW electric power experimental fast reactor is planned for completion around the year 2000. When this fast reactor is completed, China will become one of the few nations of the world with a fast reactor.

China began studying fast reactors back in the 1960's. Since 1987, fast reactor research has been included in the "863" high-tech research plan. Through the efforts of large numbers of S&T workers, breakthrough advances have been made in fast reactor design, sodium technology, fuel materials, fast reactor safety, and other areas. When the Fast Reactor Research Center is completed, it undoubtedly will promote development of nuclear power utilization in China.

#### Reasons for Qinshan Construction Delay Detailed

916B0043B Beijing LIAOWANG ZHOUKAN  
[LIAOWANG WEEKLY] in Chinese No 5, 4 Feb 91  
pp 21-22

[Article by Wu Keqiang [0702 0344 1730]: "Why Has the Construction Schedule for the Qinshan Nuclear Power Plant Project Been Delayed?"]

[Text] There have been delays in the construction schedule from the original plan at Qinshan nuclear power plant, the first nuclear power plant designed and built by China herself. What are the reasons? Has an accident occurred? There has been much conjecture by people in China and other countries.

I recently took these questions on a visit to Qinshan, located in Haiyan County, Zhejiang Province on the northern cost of Hangzhou Bay. I saw the main structures of the nuclear island and conventional island, including six plant buildings rising loftily on the 600,000 square meter construction site, and all the auxiliary facilities had been completed. All of the installation work has been finished and the various aspects of debugging work are now proceeding quickly and in an orderly manner.

#### I. "It Would Be Better To Go a Little Slower and Cost a Little More, But We Certainly Must Be Careful"

The original plan for Qinshan nuclear power plant called for it to be completed and begin generating power by the end of 1990, but this has now been delayed until 1991. Qinshan Nuclear Power Company routine general manager Zhang Huailin [1728 2037 7792] and assistant general manager Chen Puzhi [7115 2566 0037] told me that the construction periods for the first nuclear power plant in many other countries of the world were generally very long, the shortest taking about 60 months and the longest more than 80 months. If Qinshan nuclear power plant is completed by the end of the third quarter of 1991, is connected to the grid, and generates power, it will have taken 78 months, a pace that cannot be considered the slowest in comparison.

Regarding the reasons for the delay, they said that the main ones were that the construction schedule as originally arranged was too short, some equipment arrived late, and many design and equipment problems revealed during debugging had to be resolved. They said it was not the existence of unsafe technical factors that caused the construction schedule to be delayed. General manager Zhao Hongzeng [6392 1347 2582] said "it would be better to go a little slower and cost a little more, but we certainly must be careful. This is a unanimous idea of personnel concretely involved in this work we were given by central authorities." Without a doubt, this ideology runs throughout the entire construction process at Qinshan nuclear power plant.

On the coast at the outer edge of the plant area, a large dike 1,800 meters long holds back the waves like a long dragon and blocks the surging tide. Along its slope, densely clustered wave dissipation blocks are laid in geometric rows that look something like bleachers at a stadium. On this stately sea dike, the workers are also building a wave retaining wall. Officials in the Qinshan Nuclear Power Company said that the height of the original design for construction of the sea dike was estimated on the basis of the highest tide in 1,000 years and the largest storm in 100 years. Subsequently, expert Shen Xushi [1399 6079 2514] pointed out that safety coefficients should be raised further, which required raising the height of the sea dike above the original construction design. The 50 cm wave retaining wall on top of the dike was added to raise the height of the sea dike.

There are many other safety measures to prevent any possible losses and all types of rare assumptions. Qinshan nuclear power plant can withstand a Richter magnitude 7 earthquake. Historical records for this area covering the past 1,000 years show that the biggest earthquake was not greater than magnitude 6. Now, the water drainage pump house can drain the plant site and prevent flooding if a full year's precipitation were to fall in a heavy downpour in just 1 day. However, what if there was a sudden power outage in these conditions and the pump house could not operate? Based on this type of assumption, they also decided to excavate a breach in the plant area to make it possible for it to flow away naturally when the pump house is shut down to achieve safety regardless of the conditions.

After the Chernobyl accident occurred in the Soviet Union, many people were afraid that a second Chernobyl could occur in China, especially since Qinshan nuclear power plant was located between the two big cities Shanghai and Hangzhou with their relatively dense populations. People expressed enormous concern over the degree of safety of this nuclear power plant. I felt deeply during my visit that this concern is quite unnecessary.

Besides adopting the safety measures outlined above, analysis by chief engineer Ouyang Yu [2962 7122 0056], the designer of the Qinshan nuclear power plant project,

shows that of the 400-plus nuclear power plants that have been built in the world now, Chernobyl nuclear power plant is the only one that has experienced an accident that caused injury or death to personnel. Besides serious violations of regulations by operating personnel in that accident, there were two main points related to the reactor type and structure. One was that it employed a graphite reactor. The higher the temperature in the reactor, the faster the reaction, so it is easy for a mistake to cause a major fire. Second, there was no containment vessel around the reactor. Qinshan nuclear power plant is different. It uses an internationally more mature pressurized-water reactor in which the higher the temperature, the slower the reaction, so there is absolutely no way that a loss of control can occur. Moreover, it has three safety shields. If a leakage of radioactive material were to occur, the reactor's containment vessel would seal it completely. The containment vessel is sealed and pressure-tolerant, so the nuclear safety of the reactor inside it would be ensured even if an airplane crashed into it. Consideration was given to the possibility of accidents with a probability of 1 in 1 million occurring in the design and construction of Qinshan nuclear power plant, and the corresponding safety guarantee measures were adopted.

## II. Establishing a Strict Quality Assurance System

The entire process of design, manufacture, construction, and production preparations at Qinshan nuclear power plant was carried out under a strictly controlled state, meaning that they observed the related stipulations of the International Atomic Energy Agency [IAEA] and accepted their supervision, and they observed the relevant laws and regulations promulgated in China and accepted supervision by the State Nuclear Safety Bureau. Qinshan nuclear power plant formulated a quality assurance program based on these stipulations and established a relatively complete quality assurance system and almost 900 expert quality assurance personnel are active at the construction site. Rather detailed records must be kept for all links from design and construction to production preparations.

There are 585 plants in 27 provinces and municipalities and 40 companies in 10 other countries which have supplied equipment to Qinshan nuclear power plant. When purchasing equipment, Qinshan Nuclear Power Company used quality assurance requirements and adherence to the principle "comparing goods from three manufacturers, selecting the best and discarding the inferior" for strict quality control. As a result, no quality accidents have occurred over the past few years.

The question of welding the main pipeline loops was one project that involved the highest technical requirements, the greatest difficulty, and the most complex techniques. Only a few nations in the world like the United States, France, Japan, and other developed nations are capable of independent construction. Qinshan nuclear power plant organized a group composed of leaders, workers, and technical personnel to attack key problems, and after

1 year and 3 months of exploration and over 100 experiments, they derived over 6,000 pieces of data. Several trial welds confirmed that on-site construction was possible without problems. Welding of 16 main pipeline joints was completed in October 1989. Strict external inspections and non-destructive testing showed that they met specifications on the first attempt and completely satisfied design requirements. During assessments by Chinese and foreign experts, everyone was unanimous in their view that the welds were of superior quality.

## III. Authoritative Testimony

In response to an invitation by the Chinese government, the IAEA sent a "Pre- Operation Safety Appraisal and Inspection Group" composed of 11 experts from eight countries to Qinshan nuclear power plant in April 1989 to carry out a conscientious inspection lasting more than 20 days. The experts strictly followed the work procedures stipulated by the IAEA, made assessments in the eight areas of project management, quality assurance, civil engineering, nuclear island machinery, conventional island machinery, debugging preparations, operational preparations, and personnel training, and Qinshan Nuclear Power Company organized eight corresponding groups for the matching work. The experts inspected everything at Qinshan nuclear power plant with a fine-toothed comb, including hardware, software, personnel, and other factors and finally drew a conclusion that put everyone at ease. They stated in the pre-operation safety assessment report on Qinshan nuclear power plant they submitted to the Chinese government that "all construction work at the power plant is of a high standard and is progressing satisfactorily according to international standards"; "the construction work has been carried out by technically mature personnel who completely meet specifications"; "the training plan for operating personnel is perfect"; "no safety problems were discovered". The experts predicted that Qinshan will be a safe and high-quality nuclear power plant.

The first water pressurization test of the primary loop system was carried out successfully on the morning of 5 Nov 90, another indication that the quality and safety of Qinshan nuclear power plant had passed a strict test. This experiment began in July 1990 and is currently one of the main projects among the 297 major and minor projects still being carried out. During this water pressurization experiment, they increased the pressure as specified in the relevant regulations to 219 kg (the design pressure is 175 kg) and sustained it for 17 minutes. The results were entirely normal and no leaks or equipment deformation were discovered, indicating that the quality of the entire project had attained very high standards.

## IV. A Reliable Nuclear Power Technical Staff

Analysis by experts indicates that over 90 percent of the accidents that have occurred in all of the world's nuclear power plants have been related to personnel factors, and 55 percent were related to operational errors. This shows

that training good quality, high level professional nuclear power personnel, especially the operating staff of a nuclear power plant, is the primary task in nuclear power plant construction.

Most of the engineering and technical personnel at Qinshan nuclear power plant came from units under the jurisdiction of the Ministry of Nuclear Industry and Ministry of Water Resources and Electric Power. They have been involved in the nuclear industry and conventional power industry for a long time and have rich experience in reactor and thermal power plant construction and operation. There are over 100 senior engineers and over 200 engineers among them.

Despite this, Qinshan Nuclear Power Company has not neglected technical training work for its personnel. They adopted systematic training methods commonly used in the world's nuclear power industry and formulated training procedures and implementation plans on the basis of laws, regulations, and stipulations promulgated by the state and the State Nuclear Safety Bureau and in accordance with IAEA safety regulations for chief engineers and management personnel in all departments and for personnel at all posts under their jurisdiction. They have organized 40 training classes for their units over the past few years, sent several personnel to reactor plants and conventional power plants in China for study and examinations, and invited 42 experts from over 10 countries to come to China for lecturing, discussions, and consultation.

All of the 35 operating personnel in the main control room at the nuclear power plant are graduates of Qingshua University, Shanghai Jiaotong University, and other well-known universities, and 10 of them have operated production reactors and research reactors in reactor plants. Some are engineers with over 10,000 hours of operating shift experience at nuclear reactors. Qinshan Nuclear Power Company has carried out reinforced training of these operating personnel based on high standards. They were sent to foreign countries for training in 1987. They were trained on a full-scale simulator in Spain, and some simulated the entire accident process at the Three Mile Island nuclear power plant in the United States. After 9 weeks, all of them passed their examinations and obtained Spanish nuclear power plant operator specifications permits. Subsequently, they also went to posts at Krsko nuclear power plant in Yugoslavia for study. They also underwent a series of training after returning to China.

The first group of operating personnel at Qinshan nuclear power plant is also China's first nuclear power operating staff. They have already received approval from the IAEA "Safety Appraisal and Inspection Group". Experts in the inspection group felt that these personnel "were the most experienced and most superior elements transferred from China's entire nuclear industry system".

### **Qinshan Expected To Produce Power Before End of 1991**

*916B0035B Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 28 Jan 91 p 1*

[Article by reporter Zhang Heping [1728 0149 1627]: "Qinshan To Connect to Grid and Generate Power in 1991, China's Installed Nuclear Power Generating Capacity Will Reach 6,000MW By the End of This Century"]

[Text] The first nuclear power plant built in China, Qinshan nuclear power plant, will be connected to the grid and generate power during 1991. China will place one nuclear generator into operation to generate power each year over the next 3 years, with a total installed generating capacity of 2,100MW. China hopes to attain a total installed nuclear power generating capacity of about 6,000MW by the end of this century.

I learned this during a work conference of the China Nuclear Industry Corporation held on 26 Jan 91.

It was revealed that China is now building and will build a 300MW generator in the first phase of the Qinshan nuclear power plant, and that projects have been established for two 600MW generators in the second phase of the Qinshan project and a 300Mw generator for the minor second phase of the Qinshan project; two 1,800MW generators at Daya Bay nuclear power plant; and two 1,000MW generators in Liaoning Province.

The Qinshan nuclear power plant first phase project has now entered the comprehensive debugging stage. Daya Bay nuclear power plant has entered the peak activity stage in equipment installation for the No 1 generator, the containment vessel for the No 2 generator has been topped off, and it is now moving into the installation stage. Preparatory work for the second phase of the Qinshan project has now completed the overall design, opening of water, power, highways, and communications to the construction site have been completed, and various preparations for the basic design and start of construction are now pushing forward. A capital raising program is now being implemented for the minor second phase at Qinshan. The nuclear fuel element production line associated with the Qinshan nuclear power plant has been completed and gone into operation and first heat production tasks have been completed. In January 1991 and April 1989, the International Atomic Energy Agency sent two expert groups to make a comprehensive assessment of progress at Qinshan nuclear power plant, and they gave it good evaluations.

Nuclear power construction in China will develop even further from 1993 to 1995. The peak construction periods will begin for two 600MW generators in the second phase and 300MW generator in the minor second phase at Qinshan.

Indications are that China will adhere resolutely to the principle of quality first and safety first in nuclear power

construction, do solid work at nuclear power plants now under construction and designed for construction, and organize uranium ore resource surveys and matching construction for uranium ore smelting and nuclear fuel

recycling. Nuclear power will form a significant scale by the end of this century and lay a material and technical foundation for large-scale development of nuclear power during the 21st Century.

**Present Situation of Energy Conservation Outlined**

916B0047A Beijing ZHONGGUO NENGYUAN  
[ENERGY OF CHINA] in Chinese No 1, 25 Jan 91  
p 3-8

[Outline of a report on the status of action-items of the State Council's Fifth Official Energy Conservation Conference presented to the Sixth Official Energy Conservation Conference by Vice Minister of the State Planning Commission, Ye Qing]

[Text]

**1. State of the State Council's Fifth Official Energy Conservation Conference**

The State Council's Fifth Official Energy Conservation Conference, which was convened on 2 June 1989 after a 2-year interval, at a time when energy conservation activity was in a hiatus, fired up the interest of the various regions and sectors. Since last year the various sectors and regions employed a myriad of measures to carry out the strengthened energy saving measures and suggestions proposed by the take-action conference.

Up to now, 22 provinces and cities and 10 major energy-consuming sectors have held official local and industrial conferences to spread the spirit of the speakers who addressed the State Council's Fifth Official Energy Conservation Conference, among whom, Liaoning, Shaanxi, Zhejiang, Hunan, Shanghai, and the metallurgy, transportation, and chemical sectors systematically presented items for action. Hunan, Henan, Hebei, Shandong, Jiangxi, Beijing, Tianjin, and the Nonferrous Metals General Corporation followed suit with concrete measures to strengthen organization, encourage investments, and tighten controls.

It is evident after a year or so of taking action, that energy conservation has been re-energized by the measures and suggestions put forth at the fifth official conference:

In spreading the word for energy conservation, many areas and sectors were very creative: in 1990, Shanghai launched an ambitious "Save Energy Week" and held its "Sixth Shanghai Energy Saving Products and Energy Technology Exchange Conference"; in August 1990, Anhui Province held its "First New Energy Saving Products Technology Exchange and Promotion Conference, and its "Save Energy Week" activities; in September, Zhejiang Province held a 1990 Xihu Energy Saving New Technology Products Fair; in October, the Shandong Provincial Government convened an "All Province Conservation and Comprehensive Use of Natural Resources Conference", and held a 10-Year Energy and Water Conservation Technology Achievements Exhibit; and in October, Qingdao City held its "Qingdao 1990 Conservation and Comprehensive Use of Natural Resources Week. Even more important, in the last year or so, comrades Jiang Zemin, Chen Yun, Li Peng, and Zou Jiahua, on numerous occasions, have given their full

support and encouragement to energy and water conservation issues, with eminent results.

In strengthening overall controls: The (On Provisions for Encouraging the Development of Serial Manufacture of Small Heat & Electric Generators and Strictly Limiting Small Condenser-type Thermoelectric Generators) which was passed in principle at the last conference, was passed down by the State Planning Commission in early August 1989; (On Provisions for Saving Electricity in Public Use and Construction) is being put to the test in Beijing, Shanghai, and Guangzhou; (Regulations on the Administration of Development and Use of Geothermal Resources) has been submitted to the State Council Law Drafting Bureau for examination and approval; the State Planning Commission has proposed that the coal, metallurgy, chemistry, nonferrous metals, and agriculture sectors draft the (Certain Economic Policies on the Development of Five Small Industrial Enterprises); the (Temporary Regulations on Saving Raw Materials) may be passed this year; in November 1989 the State Planning Commission began to arrange, and now has completed a trial draft of the (Discussion Paper for the [Energy Conservation Law]); and the State Council Law Drafting Bureau has already placed the (Energy Conservation Law) in the national energy resources legal system, and has prepared a request for its formal status.

To give teeth to the energy saving laws and regulations already on the books, a nationwide study was undertaken in 1990 to set the conditions for enactment of (Temporary Regulations for Administration of Energy Conservation), (Temporary Regulations on Certain Questions Relating to Development and Comprehensive Utilization of Natural Resources), and (Views on Strengthening Rural Energy Resource Construction). It was this study that was the impetus for the surge in this year's energy construction efforts.

In carrying out the evaluation of the energy conservation goals, the State Planning Commission and State Statistics Bureau issued a joint document requesting seasonal announcements and evaluations of the energy consumption targets of the main products of the various sectors.

In scaling up investments, not only did the regions and the sectors institute procedures for boosting investments, but special national funding for energy saving technology was increased from 160 million yuan in 1989 to 250 million in 1990, but that did not bring them back up to the 640 million yuan annual average of the Sixth 5-Year Plan.

In setting up a system for official energy conservation conferences to further bolster their efforts, several provinces and cities may support meetings to study, resolve, and coordinate the major problems of energy conservation.

In view of the above developments, it is clear that the State Council's Fifth Energy Conservation Conference was a major stimulus for generating energy conservation actions throughout the country.

## 2. The Present State of Energy Conservation and Major Existing Questions

1990 is the last year of the Seventh 5-Year Plan, and in the last 2 years of the period energy conservation workers around the country faced ever greater difficulties and unfavorable factors, nonetheless, they have persevered and have enjoyed successes. It is anticipated that the cumulative savings in energy resources during the Seventh 5-Year Plan will amount to 80 million tons of standard coal. For each 10,000 yuan of the gross value of industrial production the consumption of energy moved from 10.5 metric tons of standard coal in 1985 to 9.6 metric tons in 1990, for an annual average rate of energy savings of 1.8 percent. Energy consumption for key products also fell. The expected energy consumption of 1.75 tons of standard coal per ton of steel dropped to 1.62 tons; the energy consumption of 1,380 kg of standard coal for each ton of ammonia at a large nitrogenous fertilizer factory fell to 1357 kg; the consumption of standard coal per ton of cement for key enterprises went down from 205.1 kg to 200 kg; for each crate of plate glass the energy consumption fell from 30.76 kg to 29.1 kg of standard coal; for each ton of electrolytic aluminum consumption of DC electricity dropped from 15,047 kWh to 14,555 kWh. It is, therefore, abundantly evident that there has been an increase in savings.

Since the last half of 1989, as administrative adjustment moved forward, new problems and new situations began to emerge in China's economic development, for example: the speed of production regressed, markets softened, stockpiles grew, and businesses were hurting. These factors directly affected development of energy conservation and the fulfillment of energy conservation plans. According to statistics from the State Statistical Bureau, the use of energy resources in 1989 increased 6.45 million tons, and this year (1990) there will be no savings in energy. The main reason is: 1. High energy consuming industries grew at a faster rate than low-energy consuming industries, and that drove up the consumption of energy resources; 2. The production tasks of many enterprises were not fulfilled. Energy-consuming facilities could not keep up a balanced output, and the proportion of supplementary production was increased; 3. A number of business leaders were more interested in opening up markets and pushing sales than in energy conservation and controlling energy consumption. Of course, the results of energy conservation in these last 2 years were not ideal, but it doesn't mean there were no successes. The per unit consumption for products of some sectors was effectively lowered, for example, in metallurgy and chemistry. So, in assessing the amount of overall savings, the savings attributable to the reliance of various ministries on technological advancements and scientific controls to lower the per unit consumption of products must be emphasized. At the 13th National Party Congress it was pointed out that the course of China's economic development is from an extensive to an intensive economy, and saving energy and cutting consumption is one of the routes to economic change. The merits of this process of change, to a

large degree, obtain through the success of energy conservation and reduction of consumption.

Although China has achieved notable successes in energy conservation in the last 10 years, the utilization rate of China's energy resources is low, per product consumption rate is high, economic profits are low, and the serious situation of wasting energy is basically unchanged. The environmental protection problems interrelated with energy conservation and comprehensive use of natural resources becomes more evident each day, and shows that it is even more necessary to have a rational utilization of energy resources and comprehensive use of natural resources.

There are over 800 million peasants in China, and as the rural economy develops the consumption of energy resources in agricultural villages will expand rapidly, and the annual excess consumption of 200 million tons of biomass energy per year will cause the ecological environment to change. There are as yet no effective controls, and the task of rural energy resource construction is ominous.

In looking at the energy resources supply situation, at today's consumption levels, the GVIO in the year 2000 will be quadruple that of 1980, and the energy requirement will be 1.76 billion tons of standard coal. As initially programmed, the energy resource output will only reach 1.36 billion tons of standard coal. In the final 10 years the average annual rate of energy savings must be 2.8 percent. What has actually been accomplished in the last two years has been very difficult, and therefore there must be an even more resolute policy of giving equal weight to development of energy resources and energy conservation in order to give strength to effectuating a savings in energy and reduction of consumption. It must be recognized that even though energy conservation faces many difficulties, there are many benefits to be gained from furthering energy conservation and reduction of consumption: 1. The Party Central Committee and State Council leadership are keenly aware and solicitous of energy conservation endeavors, and are giving it much important guidance; 2. The key point of current economic efforts is to raise economic profits. Especially since the State Council designated 1991 as the "Quality, Product Variety, and Profits Year", energy conservation and reduction of consumption will be one of the main routes to raising economic profits, and primary focus of technological reform is being put on energy conservation and reduction of consumption, and this will be a great stimulant for energy conservation and reduction of consumption efforts; 3. The sectors and industries have begun to recognize the importance of energy conservation and reduction of consumption, and have raised their consciousness, and finally, current administrative adjustment has been clearly effective in creating a proper growth of the economy, raising energy resource production, harmonizing supply and demand, and this will be the best mechanism for adjusting output, business, product structure, and the advancement of energy conservation and reduction of consumption.

The main problems in energy conservation are:

1. The important message of the energy conservation and reduction of consumption effort is that there is insufficient awareness.

Generally speaking, many leaders' and cadres' conservation consciousness is still rather poor. They are strong on development and weak on saving, stress speed and disregard effectiveness, strong on output volume and insensitive to consumption, and their mindset has remained basically unchanged. The main manifestations are: they give lip service to energy conservation and reduction of consumption, but do very little; they are high on meetings and papers, but short on daily agenda; they work hard to learn about per unit consumption, and do little about adopting measures to lower the consumption of various materials. Especially when output doesn't rise, and conditions are unfavorable for product sales, energy conservation and reduction of consumption is often disregarded. Another problem worthy of attention is the shortage of advertising and education. The consciousness of the general population is weak, and that leads to much unnecessary waste of energy resources.

2. Funds for energy conservation are insufficient and inappropriate for the energy conservation mission.

Basically speaking, the advancement of energy conservation and reduction of consumption must depend on the progress of technology. Investment in energy conservation technology as compared with development of energy resources not only gets faster results, but it is more profitable. Even without considering the outside investments in railroads or electric power transmission, each ton of energy resource gained through investment in energy conservation costs one-third less than that derived through investment in opening up new resources, and considering the benefits to society in terms of environmental protection and saving of natural resources, investment in conservation is even more worthwhile.

At present, China's energy conservation investments and efforts are not at all satisfactory. Much of the funding for technological reform for energy conservation funneled to localities and key energy consuming businesses are not up to the minimum of 20 percent of past funding as stipulated in the State Council's (Temporary Regulations for Administration of Energy Resource Conservation). The proportion of investments that go into new technology for energy conservation has been going down every year.

3. Energy conservation is organizationally weak and preferential policies are not working well.

From the aspect of energy conservation administrative structure, the general situation is that the central ministries are not as effective as the provinces and cities. There are three main aspects to this problem: one is that after the organizational reforms of the previous 2 years, a number of the offices and bureaus of the sectors,

provinces, and cities were weakened; although the work of saving raw materials has already been stressed for many years, some sectors still haven't designated anyone to do the work. Two is that many localities and cities do not have special organizations responsible for saving and comprehensive use of natural resources, and many medium and small businesses do not have people specially designated for energy conservation tasks, and in the villages and towns this is even more the case. Third is that some of the cadre of the provinces and cities responsible for energy conservation aren't formally entered into the administrative establishment, and that adversely affects the stability of their units.

Because of the effects of the policy of guaranteeing profits to the sectors, as well as the local financial guarantees, the national policy of giving preference to energy conservation, comprehensive use of natural resources, and rural energy resources is not being carried out well in some localities and sectors, and in the arranging of investments and projects, there is even less reflection of this preferential policy.

### 3. Primary Measures of the Eighth 5-Year Plan to Strengthen Energy Conservation

As Comrade Li Peng stated in his May 1990 dedication to Shanghai's "1990 Save Energy Week", the policy of giving equal merit to energy conservation as well as development must be adhered to, and all businesses and enterprises must give prominence to energy conservation. In the last 10 years, the main task of China's energy conservation has been to diligently carry out Li Peng's instruction. For this reason it is important that the following measures be enforced.

1. Heighten awareness of energy conservation and reduction of consumption.

In 1991, the energy conservation efforts of the Seventh 5-Year Plan should be summed up in earnest, good people and good deeds should be publicized energetically, and advanced units and individuals who deserve it should be commended. Beginning in 1991, "National Save Energy Week" activities should be held once each year, and energy conservation campaigns should be gradually intensified every year. "Energy conservation consciousness", "natural resources consciousness", and "environmental consciousness" should be further cultivated throughout the society.

Conserving materials is an aspect of energy conservation that can't be overlooked. Saving materials raises profits and lowers consumption. It makes up part of the effort to reduce consumption per unit of the GVIO, and the various levels of leadership should pay close attention to it.

2. Place emphasis both on increasing and conserving energy conservation and reducing consumption through strengthened macromanagement and micromanagement.

## CONSERVATION

(1) Create a stronger administrative system. The administration of conservation and comprehensive use of national natural resources should be further strengthened, and the responsibility for organizational administration of energy conservation, saving materials, and comprehensive use of rural energy resources and natural resources should uniformly lead back to the State Planning Commission. This should be gradually increased according to the circumstances and not be allowed to weaken. Depending on the conditions, there should be special persons designated to handle energy conservation and reduction of consumption in village and town enterprises.

(2) Formulate a realistic plan for energy conservation goals, and link them to distribution and supply. This should be considered in formulating and implementing the Eighth 5-Year Plan. The allocation of energy resources should be apportioned in appropriate measures according to the extent to which businesses have accomplished their energy conservation; on the supply side, the energy conservation administrative departments should categorize businesses according to their consumption levels, and refer this to the supply departments to select supplies preferentially. Businesses that consume excessively should receive warnings, supplies should be cut, and they should be supervised and coerced to adopt energy conservation and reduce consumption measures with utmost speed.

(3) Enterprises that have an annual consumption of 2,000 tons or more of standard coal must raise their level of energy saving before they can increase the scale to their enterprise.

(4) Uphold and perfect a system of checks on energy consumption for key products, penalize excesses, and publicize and reward the use of technological reform for energy conservation.

(5) Further develop energy conservation contracts, and bring savings goals into factory management tenure records.

### 3. Promote technological advancement.

The Eighth 5-Year Plan measures for technological advancement are: small heat and power cogeneration, conversion to water pumps and wind generators, conversion of industrial boilers, energy conservation construction, residual heat power generators, and water conservation. In 1991 there must be an emphasis on saving oil and electricity. The measures intended for adoption are:

(1) increase efforts to save oil. Enforce the (Strengthen Controls on Oil Consumption and Conserve Use) and study concrete measures for oil conservation.

(2) Place energy conservation and reduction of consumption in the forefront of technological reform: 1. link energy conservation results to funds for technological reform. 2. In the various regions and sectors, take energy conservation and reduction of consumption as the chief

items of reform, and this should be signed, examined, and approved by the departments and committees in charge. 3. The energy consumption indicators for technological reform projects for energy conservation should be considered.

(3) Use the authority to examine and approve capital construction and technology reform projects for the energy consumption. All of the large and medium-sized capital construction and technological reform projects for new construction, expansion, and reconstruction must have energy conservation indicators and measures for comprehensive use of natural resources, and must be signed, examined, and approved by the departments and committees in charge of energy consumption and comprehensive use, without which they will not be granted official status.

(4) According to their status, each year a group of technological measures for energy conservation and reduction of consumption that have saved on investments, and have good and quick results should be selected and broadly applied. Finance, banking, taxation, and commodities departments should be treated separately according to investments, interest, revenues, or commodity supply.

(5) Speed up the elimination of high energy consuming products, and actively spread the use of new energy saving technology. The emphasis next year will be on phasing out old gas consuming vehicles and ships etc., and expanding the use of energy saving products. It has been announced across the country that those products which are to be eliminated that have exceeded their output limits will no longer be permitted to be manufactured. Permits for production must be re-authorized by production and energy conservation administrative departments; as for obsolete facilities that are still in use, the various regions, ministries, and enterprises must lay out rules and measures for eliminating them. Relevant departments must also be organized to actively research and manufacture new energy saving products and new technology to replace the old energy consuming products and old technology.

### 4. Continue to increase capital investments.

National, local, sector, and enterprises, within the limits of their finances, must in every way possible make investments in energy conservation and reduction of consumption. The State Planning Commission funding of energy saving capital construction and technological reform should be properly increased.

The State Council's (Temporary Regulations for Administration of Energy Conservation) stipulates that 20 percent of old funds be used for technological reform for energy conservation. The various levels of administrative departments for energy conservation must be responsible for checking and implementing this. The provinces and cities, according to their own actual

situations, should set up special funds for energy conservation and comprehensive use, and they should open up a variety of funding channels.

### 5. Build a stronger legal system.

(1) Formulate the (Energy Conservation Law). Request that work on establishing and drafting the law be stepped up, and efforts be made to promulgate it in the Eighth 5-Year Plan. Also, preparations must be made for the (Comprehensive Utilization of Natural Resources Law). As to those urgent questions that must be solved now, revisions must first be made to the present regulations, and they should be resolved quickly.

(2) The existing preferential policies for natural resource conservation and comprehensive use should be better enforced. The three documents released and circulated by the State Council: (Temporary Regulations for Administration of Energy Resource Conservation), (Views on Strengthening Rural Energy Resource Construction), and (Temporary Regulations on Certain Questions Relating to Development and Comprehensive Utilization of Natural Resources) must be further enforced, and the preferential policies contained within them must be diligently observed.

Hereafter, the State Planning Commission together with relevant finance, taxation, and banking departments, in the process of earnestly studying and implementing the documents, will propose measures for resolving problems as new situations arise. They will also assess the present concrete conditions, research and propose new preferential policies for energy conservation, reduction of consumption, and comprehensive use.

### Nation Cautioned Against Relaxing Conservation Effort

916B0023B Beijing JINGJI RIBAO in Chinese  
7 Nov 90 p 2

[Article by JINGJI RIBAO reporter Xie Ranhai [6200 3544 3185]: "Energy Conservation Work Must Not Be Relaxed"]

[Text] The gathering clouds of war in the gulf crisis have let everyone know that the shadow of a third energy crisis is now hanging over the world

#### What is the situation in China?

Data provided by the State Statistics Bureau show that as we continue to maintain a momentum of sustained stable growth in energy resource production and the rate of industrial growth drops, China's energy resource shortage is now being alleviated temporarily.

However, the appearance of a temporary reduction in the energy resource shortage has caused relaxation of energy conservation work to raise its head and more energy wasting phenomena like gas-burning "sky lamps", residential lane "eternally lit lamps", machinery

running uselessly, buses gathering in tourist regions, and so on are appearing in greater numbers.

Looking at the paths taken by the developed nations, when a country is in the economic takeoff period, a rational and economical elasticity coefficient between the rate of growth in industry as a whole and the rate of growth in the electric power industry is 1:1.1, meaning that when the rate of industrial growth is 1, the corresponding rate of growth in the electric power industry is 1.1. Economic operations in China during the first half of 1990, however, show that the ratio between the rate of industrial growth and the rate of growth in the electric power industry far exceeds this elasticity coefficient. During the first half of 1990, the rate of industrial growth was 2.2 percent while the rate of growth in electric power output was 6.3 percent, so the elasticity coefficient between the two was about 1:3.

Electricity is a commodity that cannot be stored. Relaxation of energy conservation work and severe waste of energy resources can be viewed as the same thing. For this reason, the relevant experts have pointed out that in view of the changeable situation in energy resource supply and demand over the past several years and the economic development goals that we wish to attain, the outcome of continued development according to existing conditions will be extremely serious.

Looking at the current situation, there are three main causes of the improvement. One is that long-term shortages in China's coal markets compelled several economically developed regions in China which consume large amounts of coal while facing shortages of coal to implement strict control and utilization measures regarding coal burning in the early 1980's, for example, Jiangsu's closing of all the province's small power plants under 6 kW which consumed large amounts of coal. The second cause was that output failed to decline at Xuzhou, Kailuan, and other old mining bureaus with convenient communications. The third was that a development "leap forward" appeared in small township and town coal mines which are spread throughout China.

However, people who succumbed to the intoxication that "the coal problem has been solved" were unwilling at the time to scientifically analyze the conditions of a temporary saturation of coal markets, and the result was that some small power plants which had been shut down resumed operation. Moreover, construction also got underway on high energy consuming projects whose construction and startup had previously been strictly controlled and they went into operation. The yearly increases rose from tens of millions of tons to hundreds of millions of tons. Added to declining output at Xuzhou, Kailuan, and other old mining bureaus and fruitless extended tunneling at small township and town coal pits, large numbers of mines and shafts were abandoned. The shadow of a comprehensive coal emergency once again covered China during the last half of 1988

and eventually led to the state being forced to adopt measures for comprehensive readjustment of the national economy.

After more than a year of improvement and rectification, it would seem that a tendency toward reduced shortages of energy resources has reappeared in China. Does this indicate that there has been a fundamental turnaround in the contradiction of total demand for energy resources in China exceeding total supplies? The answer is no.

Forecasts by relevant departments in the State Planning Commission indicate that based on again doubling China's GNP by the year 2000, the annual growth rate is estimated to be a rate of 6 to 7 percent, so demand for energy resources in 1995 will be 1.4 billion tons of standard coal. At that time, the energy resource industry will only be able to supply 1.2 billion tons, so there will be a shortage of 200 million tons. Demand for energy resources will be 1.7 to 1.8 billion tons in the year 2000, and the energy resource industry will only be able to supply 1.4 billion tons at that time, so we will have a development of 300 to 400 million tons.

What method can be used to compensate for such a large shortfall?

We can of course place our hopes on a "leap" in the energy resource industry and use increased output to provide more energy resources to develop the national economy. However, hopes cannot replace reality. Because the prices of energy resource products have been too low for many years, China's energy resource industry suffered comprehensive losses for years in succession and is now on the verge of losses. Thus, it is rather hard now to even maintain simple reproduction. In this

situation, how can we set aside even more capital to invest in expanded reproduction?

Can we place our hopes on increased state investments?

State finances have been in the red for several years. Added to a reduction in central revenues as a proportion of total national financial income, the state cannot set aside more financial resources to develop energy resources.

Thus, energy conservation and reduced consumption are the most realistic choices for ensuring that our magnificent goals for the year 2000 are achieved on schedule and that we can compensate for enormous shortages. There is still great potential we can exploit in this area.

According to the relevant data, when the GNP of most of the world's industrialized nations reached China's present level, their total consumption of energy resources was generally about 400 million tons of standard coal, but China now consistently consumes over 900 million tons of standard coal, so we are using more than double the energy resources!

Moreover, it was revealed in the document "World Energy 1988-1989" published jointly by the World Energy Resource Institute in Washington and London and the International Institute on the Environment and Development, among 10 large countries excluding the Soviet Union, China consumes the most energy to produce \$1 in GNP, 4.97 times the amount in France, 4.43 times Japan, 3.82 times Brazil, and 1.64 times India.

This shows us that if we can reduce our present excess energy consumption by one-half by the year 2000 and approach or reach the level in Brazil, we could support the magnificent goal of again doubling our GNP by the year 2000 without any substantial increase in total energy resource output over present levels.

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